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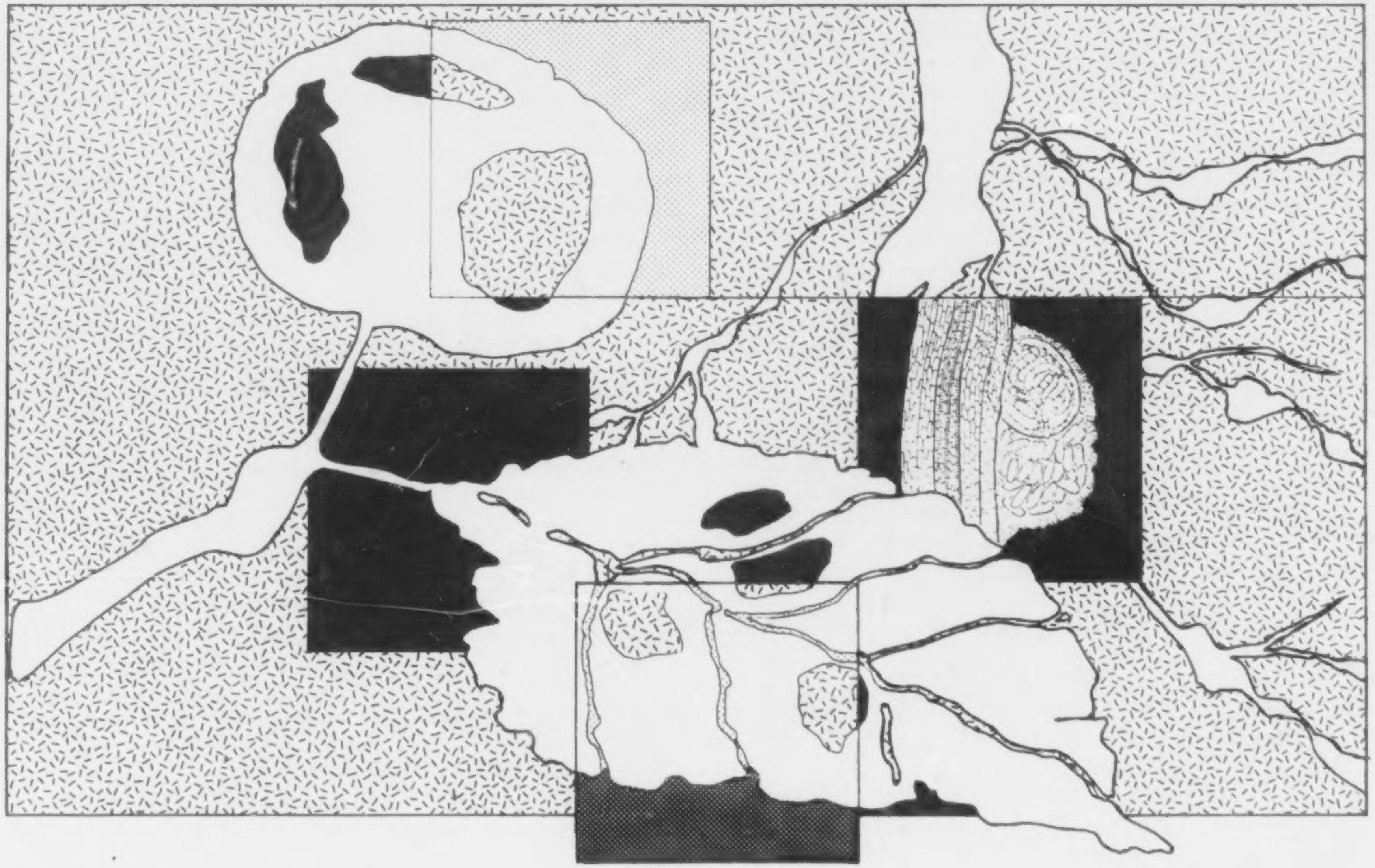
**United States
Department of
Agriculture**

Agricultural
Research
Service

Agriculture
Handbook
Number 656

Guidelines for the Control of Plant Diseases and Nematodes



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USE OF PESTICIDES

This publication is intended for nationwide distribution. Pesticides are registered by the Environmental Protection Agency (EPA) for countrywide use unless otherwise indicated on the label. State registrations (intrastate labels, special local needs registrations, and special, specific, and emergency exemptions) are not included in this handbook due to the ephemeral nature and limited geographical range of these registrations. The suggestions and guidelines in this handbook are general in nature and are not to be regarded as recommendations; they do not allow for varying soil types, climates, and agricultural practices. Specific use recommendations should be made by local, county, or State production specialists.

The use of pesticides is governed by the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended. This act is administered by EPA. According to the provisions of the act, "It shall be unlawful for any person to use any registered pesticide in a manner inconsistent with its labeling." (Section 12(a) (2) (G))

Mention of a pesticide in this publication does not constitute a recommendation by the U.S. Department of Agriculture. Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture and does not imply disapproval of other products that may also be suitable.

The optimum use of pesticides, both as to rate and frequency, may vary in different sections of the country. Users of this publication may also wish to consult their Cooperative Extension Service, State agricultural experiment stations, or county Extension agents for information applicable to their localities.

The pesticides mentioned in this publication are often available in several different formulations that may contain varying amounts of active ingredient. Because of these differences, the rates given in this publication refer to the amount of active ingredient, unless otherwise indicated. Users are reminded to convert the rate in the publication to the strength of the pesticide actually being used. For example, 1 pound of active ingredient equals 2 pounds of a 50-percent active formulation.

The user is cautioned to read and follow all directions and precautions given on the label of the pesticide formulation being used.

Federal and State regulations require registration numbers. Use only pesticides that carry one of these registration numbers.

The pesticides mentioned in this publication were federally registered for the use indicated as of the issue date of this publication. The user is cautioned to determine the directions on the label or labeling prior to use of the pesticide.

PREFACE

This handbook is intended as a guide for plant pathologists, nematologists, and other research and extension workers rather than for use by individual growers. It indicates uses of chemicals and of alternative measures for the control of plant diseases and nematodes that affect crops. The information was prepared by scientists of the Agricultural Research Service (ARS), U.S. Department of Agriculture, and by scientists of the Cooperative Extension Service (CES) and is based on results obtained by Federal, State, and other research orgainzations.

The handbook does not contain recommendations but is intended to supplement information and recommendations issued by State agencies. The treatments it indicates do not necessarily apply to all areas or parts of the country. There may be other registered uses of these pesticides that meet the requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as amended and the Food Additives Amendment of 1958 to the Federal Food, Drug, and Cosmetic Act.

This handbook supersedes Agriculture Handbook 378 "Guidelines for the Chemical Control of Plant Diseases and Nematodes," issued January 1974.

Hilde McGrath, Agricultural Research Service, Beltsville, MD, was editor of the fungicides portion of this handbook; Julius Feldmesser, Agricultural Research Service, Beltsville, MD, and Lawrence D. Young, Agricultural Research Service, Nematology Research, Mid-South Area, Jackson, TN, were editors of the nematicides portion.

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GUIDELINES FOR THE CONTROL OF PLANT DISEASES AND NEMATODES

Edited by Hilde McGrath, Julius Feldmesser, and Lawrence D. Young

APPLICATION OF FUNGICIDES AND NEMATICIDES

Plant diseases and nematodes cause damage to crops that reduces the quantity and quality of the product. The total annual losses in agricultural production from plant diseases and plant-parasitic nematodes in the United States alone are estimated to amount to 10 and 7 percent, respectively, despite the widespread use of control methods on important crops. In 1985 dollar values, these estimated damages may total $6 billion in each category. Obviously, without controls, the losses would be much greater, even disastrous, under conditions optimal for damage.

Control methods include: The use of disease-resistant and nematode-resistant varieties; cultural methods, such as deep plowing to bury infested debris, changing time of planting, or manipulating moisture supply; production of disease-free and nematode-free seed and plants in locations free from the disorder; biological control to take advantage of interactions among soil-inhabiting organisms; and use of chemicals.

The key to effective use of a pesticide without injury to the treated plant or agricultural product is to follow directions on the label. Do not use any preparation for any purpose for which it is not specified.

Only general information can be given in this guide on the effective application of fungicides and nematicides since much depends on the commodities to be treated, weather and soil conditions, and application equipment, as well as the type and formulation of the pesticide to be applied. For information to meet special needs, consult your State agricultural experiment station.

Pesticide Applicator Training

Pesticides are of benefit to society if used in accordance with label instructions and good agricultural practice; however, uninformed and (or) careless applicators are a hazard to themselves and society. FIFRA, as amended, requires that re-restricted use pesticides be applied only by or under the direct supervision of a certified applicator. Anyone who uses pesticides on a regular basis should be encouraged to seek pesticide applicator training. Consult your State Department of Agriculture or local cooperative Extension agent for information about pesticide applicator training courses in your area.

Weather Conditions

Variations in moisture, wind velocity, temperature, and sunlight may affect the application of pesticides and their efficacy afterward. Plan ahead and try to follow suggestions on pesticide labels and the advice of county agents and other local production specialists. Watch the tops of trees or use other means to determine the direction and amount of wind. Some air movement is helpful.

Winds, however, can cause a pesticide dust or spray to be unevenly distributed on the plants and to drift away from the target areas.

If rain is predicted, postpone treatment, if possible. Rain falling soon after you treat, or cold weather, may reduce the effectiveness of a pesticide deposit. Some pesticides must be applied at temperatures above 50°F to be effective.

Extremes in weather during or following the spraying of fruit trees may cause fruit or foliage injury. Russeting of fruit may be increased by pesticide sprays if they are applied at night or during cool, rainy, or humid weather. Emulsifiable materials are more likely to cause injury than are the wettable powders.

Condition of Host Plants

The type and density of plant foliage, as well as the extent of coverage needed, may influence the choice of formulation that is applied. In some instances, a coarse spray is more effective; in others, a fine spray, mist, or fog will be more effective. Plants with smooth leaves are likely to have a quicker runoff of spray material than those with rough leaves. However, stickers that are included in the formulation, or that may be added, help the material adhere to the plants.

Calibration of Equipment for Applying Pesticides

At the start of each growing season, thoroughly inspect and calibrate all equipment to be used in applying pesticides. Repeat whenever a different rate of application is used. Apply the correct dosage, not only to control the pests effectively but also to avoid plant injury and to be certain that any residue remaining at the time of harvest or feeding does not exceed the tolerance established for that particular chemical on the crop treated.

Power sprayers.--Before calibration, the spray nozzles should be checked for obvious wear, foreign material, and choice of proper type and size. Where the sprayer has many nozzles, the flow rate of each nozzle should be checked using water at the planned operating pressure by catching all the spray for a measured time. Nozzles that differ by more than 5 percent from the average of the rest should be replaced. If possible, the sprayer should be initially calibrated with a liquid containing no pesticide but similar in weight and viscosity. Then, the calibration should be confirmed by measuring the application of a small measured amount of actual pesticide mixture when beginning on the area to be treated and the equipment or the mixture ratio adjusted to correct for the change, if any, in the rate with actual pesticide material. Usually, water is the most logical material to use for calibration, but occasionally some pesticide mixtures flow more like fuel oil or vegetable oil, in which case these mixtures should be used for calibration. When a liquid containing no pesticide can be used for calibration, the user can use the "Simplified Method" described below. If the pesticide or the sprayer construction somehow requires use of the actual pesticide for realistic operation, then the "Full Calculation Method" must be used.

Simplified Method: (1) Place two markers (such as stakes and cans) on the ground 660 feet apart. (2) Partially fill the sprayer with water (or the other liquid being used) and operate until all nozzles are discharging evenly. Fix a vessel of appropriate size (a 2 1/2-gallon can, for example) under one nozzle so that it will collect all the spray coming from it. (3) Operate the sprayer one round trip between the markers at the speed, pressure, and other settings that you intend to use, with the sprayer in full operation. Spray only between the markers. (4) Measure the amount collected from the nozzle and multiply it by the total number of nozzles to get the total amount sprayed.

(5) Multiply the number of gallons sprayed by 33 and divide by the number of feet of width sprayed. The result of this calculation will be the number of gallons applied per acre.

> Example: Suppose the boom on the sprayer contained 12 nozzles and covered a swath of 20 feet, and that you collected 3 1/4 pints of spray from one nozzle during the round trip. Twelve times 3 1/4 pints equals 39 pints, or 4.875 gallons. This times 33, divided by 20, equals 8.0 gallons per acre.

It may not be practical to collect the spray used during a run in the field with certain types of equipment. Aircraft sprayers, mist blowers, and foggers are examples of such equipment. For this equipment, the amount used during the calibration run must be found from the net amount taken from the tank. To do this, the tank must be filled to an accurate liquid level mark (preferably filled to just the point of overflow). The sprayer is then operated over the calibration distance and the amount required to refill the sprayer to the same level is measured. To be accurate, the sprayer must be in exactly the same position (preferably level) both times when the level is measured. In certain types of sprayers, such as aircraft, it may not be possible to make an accurate level mark or to fill the tank to overflow. With this equipment, the sprayer must first be partially filled, then operated until all lines and booms are filled, and then the tank drained. A measured amount of liquid is then put into the tank and the sprayer is operated over the calibration distance, and the tank then drained as before, measuring the amount that drains out. The amount used is the difference between the amount that was put into the tank and the amount that was drained out.

Full Calculation Method: To calculate the application rate of the sprayer, you must know the speed of the sprayer, the width of swath sprayed, and total flow rate from the sprayer nozzles.

1. The speed may often be taken from a speedometer. If there is no speedometer available, measure the time it takes to drive the equipment at the intended speed over a measured course with the tank half full. The speed can be calculated from these measurements.

> Example: Suppose it requires 3 min and 20 seconds (200 seconds) to go 80 rods (1/4 mile). The speed equals 1/4 divided by 200, multiplied by 3,600 (the number of seconds in an hour), which would be 4.5 mph.

2. The flow rate can be calculated by multiplying the number of nozzles times the rating given by the manufacturer for operation at the pressure being used, if the nozzles are new and have not worn very much.

> Example: Suppose the sprayer has 12 nozzles rated at 0.4 gal/min at the pressure you intend to use. The total flow equals 12 times 0.4, which is 4.8 gal/min.

You may not be able to use the manufacturer's rating if the nozzles have become worn, or if the manufacturer has not supplied a rating at the pressure you intend to use, or the manufacturer's rating is not conveniently available. Then, the flow rate will have to be obtained by measuring the spray caught from a nozzle for a measured time.

> Example: Suppose there are 12 nozzles on a sprayer and you catch 1 quart and 6

> fluid ounces (38 fluid ounces) from one nozzle in 1 min. Since there are 128 fluid ounces in a gallon, the flow rate of the entire sprayer equals 38 times 12, divided by 128, which is 3.56 gal/min.

3. The swath width must be determined by a method appropriate to the sprayer being used. The swath width of an airplane sprayer, air-blast sprayer, or fogger will have to be determined from the manufacturer's literature or perhaps from a research report on the particular equipment in use. A boom sprayer will have a swath equal to the boom width plus the width covered by end nozzle, if there are nozzles on the very ends of the boom.

> Example: Suppose a sprayer has a boom 18 feet 4 inches long, having a nozzle at each end that also covers 20 inches apiece. Recognizing that only half the spray from each end nozzle will go outside the boom, the swath will be 18 feet 4 inches plus 20 inches, which equals 20 feet.

In contrast, if you are only spraying a narrow band over each row of a crop grown in rows, the total swath will be equal to the width of the band times the number of rows.

> Example: Suppose you have spray equipment attached to an 8-row planter, which sprays a 12-inch (1 foot) band over each row. The actual swath being treated is equal to 8 times one, which is 8 feet.

4. The application rate of the sprayer can be calculated when the speed, swath width, and flow rate are known. The following formula can be used to take into account the number of feet in a mile, the number of square feet in an acre, and the number of minutes in an hour.

$$\frac{495 \times (\text{total flow rate in gal/min})}{(\text{swath width in feet}) \times (\text{speed in mph})} = \text{gal/acre}$$

> Example: Suppose the flow rate is 4.8 gallons per minute, the swath width is 20 feet, and speed is 4.5 mph. Then the volume of spray applied is 495 times 4.8, divided by 4.5, divided again by 20, which is 26.4 gallons per acre.

Changing or Adjusting the Application Rate: If the application rate found from the calibration is not what is desired, it may be changed by changing the size and number of nozzles, the speed, or the pressure. If large changes are necessary, the size and number of nozzles must be changed. Decreasing the speed will increase the application rate proportionately, while increasing speed will decrease it. However, the acreage that can be covered per day will be reduced if speed is reduced, so users may not wish to make very large changes in speed. You should not try to change application rate very much by changing pressure, because this will also change the pattern and the droplet size of the spray. It is also useful to know that increasing pressure 10 percent increases the nozzle flow only 5 percent, 21 percent increases nozzle flow 10 percent, and 44 percent increases nozzle flow 20 percent, so that changing nozzle flow requires proportionately much larger changes in pressure.

Power dusters.--Before starting a dusting operation, check the application rate of the duster unit. Dust mixtures vary in density, and the application rate can vary at a given setting of the feed regulator.

1. Measure off a convenient area between one-fourth acre and 1 acre.

> Example: Eight 40-inch rows 1/4 mile long, which equals 0.808 acre.

2. Fill the dust hopper to an accurate level mark and set the dust feed regulator according to the manufacturer's recommendation for the desired application rate.

3. Dust the measured area. Drive at a constant speed because the speed affects the application rate. Use a speedometer if possible.

4. Refill the hopper to the previous level from a weighed amount of dust. Subtract from this weight the amount left over after refilling the hopper, which gives the amount applied to the measured area. This amount divided by the area gives the application rate.

> Example: Suppose a bag containing 50 pounds was used to refill the hopper, after which it contained 34 pounds. The amount used was then 16 pounds. Dividing this by 0.808 acre gives 19.8 pounds per acre.

Applicators for granules.--Many equipment manufacturers and some producers of granular pesticides provide tables showing the proper settings of the feed mechanism for selected flow rates of specific materials. This will provide an approximate guide for the user in adjusting the equipment. Because of manufacturing differences in both the granular material and the application equipment, the user should check this with a measured calibration.

Disconnect the tubes from the spreader and affix paper bags in place of the spreader to collect all the granules fed out. Run the spreader over a measured course of 1,320 feet and weigh the material collected. Multiply this weight by 33 and divide by the number of feet of width the applicator covers from the dispenser measured. This will give the pounds applied per acre.

> Example: Suppose the discharge from two tubes is to be spread over one 40-inch (3.3 feet) row width, and you collected 4 pounds of material when operating over a total of 1,320 feet (40 rods each way, round trip). Four times 33, divided by 3.3, equals 40 pounds per acre.

If this calculation shows the application rate is not what is intended, adjust the settings appropriately and repeat the calibration procedure. Remember that the feed mechanism of most granular applicators does not feed the material at a rate proportional to the speed of the equipment, even though it is often driven by a wheel on the ground. Because of this, the speed of the equipment must be constant, and the application rate can be increased or decreased by decreasing or increasing, respectively, the ground speed of the equipment.

Confirming Calibration With First Application: After calibration, you should try a partial load of actual pesticide mix to confirm that the calibration measurements and calculations were accurate. This will give you a chance to make a last minute adjustment in the operation of your equipment before treating an entire field.

> Example: Suppose a field 1/4 mile long is being treated with a sprayer having a swath of 20 feet, and the calibration indicated that it was applying 8 gallons per acre. Since 10 swaths the length of the field equal 6.06 acres, which should require 48.5 gallons, the operator might put about 53 gallons in the tank for the first load. After 10 swaths have been completed, the tank then can be checked to see about how much more or less than the expected 4.5 gallons of spray mixture remain.

USE OF PESTICIDES

Pesticide Poisoning

If you think someone has been poisoned by a pesticide, call a physician. Symptoms of pesticide poisoning are similar to those of other types of poisoning, and of other diseases. Heat exhaustion, food poisoning, and asthma are sometimes confused with pesticide poisoning. If a person becomes ill after using or being around pesticides, he may or may not be suffering from pesticide poisoning. If you are in doubt whether poisoning has occurred, let a doctor decide.

Poisoning may be chronic, a result of repeated small doses over a long period of time, or acute, resulting from one relatively large dose of a pesticide. The symptoms of chronic poisoning are extremely variable and may include nervousness, slowed reflexes, irritability, or a general decline of health. Severe symptoms of acute poisoning may include pinpoint pupils or blurred vision, intense thirst, fever, increased rate of or difficulty in breathing, trembling or muscle twitches, stomach cramps, vomiting, excessive saliva, excessive perspiration, extreme weakness, flushed or yellow skin, weeping, mental confusion, convulsions, and(or) unconsciousness. Less severe symptoms of acute poisoning are headache, fatigue, weakness, dizziness, nervousness, nausea, perspiration, diarrhea, loss of appetite, soreness in joints, and skin, eye, nose or throat irritation.

If a suspected poisoning victim is still in contact with a pesticide, remove the victim from the source of exposure as quickly as possible. Remove any contaminated clothing and wash off any pesticide that is on his or her skin with soap and water. Rinse chemical burns with large amounts of running water and immediately cover loosely with a clean, soft cloth. Do not use ointments, greases, or other remedies on chemical burns of the skin. Poison in the eye should be washed out as quickly and gently as possible. Hold the eyelids open and wash eye with a gentle stream of clean running water for 15 minutes or more. If pesticide vapors are suspected to be the source of poisoning, first remove the individual to fresh air and avoid endangering yourself in the process. If breathing stops for any reason, immediately apply artificial respiration.

A poisoning victim should be kept comfortable and quiet while waiting for medical help. Loosen all tight clothing and prevent chilling by wrapping the victim in a blanket or warm clothing if necessary. Do not give alcohol in any form.

Vomiting should be induced only if it can be determined that it will benefit the victim and medical help is not expected soon. Preferably, advice should be obtained by phone from a physician or poison control center to determine the suitability of vomiting. Never induce vomiting in a victim who is unconscious or in convulsions. Do not induce vomiting if the poison is a strong acid, strong alkali, or contains a petroleum product. The pesticide label should give information about the suitability of vomiting and will also be of help to medical personnel. If you determine that the induction of vomiting will not further harm the victim and is necessary, follow these steps: (1) dilute the poison by having the victim drink milk or water--1 to 2 cups for children up to 5 years and a quart for victims 5 years and older; (2) make sure the victim is kneeling forward or lying face down; (3) induce vomiting by putting your finger or a blunt object, such as a spoon, at the back of the victim's throat, or have the victim drink a glass of soapy or very salty water. If possible, save some of the vomitus for testing by medical personnel; (4) absorb the poison by having the victim drink a slurry of activated charcoal and water, or a mixture of 4 tablespoons burnt toast, 2 tablespoons strong tea, and 2 tablespoons of milk of magnesia.

If oral poisoning has occurred, yet induction of vomiting is inadvisable as indicated above, follow these procedures: (1) dilute the poison as indicated in part 1 of the vomiting section above; (2) neutralize the poison: for acids, give the victim milk of magnesia, baking soda, or chalk in water; for alkali, give lemon juice or vinegar; (3) absorb the poison as indicated in part 4 of the vomiting section above.

Never give atropine. Remember that it is very important to obtain medical help without delay. Your first aim is to dilute the pesticide no matter where it is. Other procedures mentioned above should only be undertaken while in transit or while waiting for medical help. If at all possible, seek advice by phone from medical personnel or a poison control center for suitable first aid procedures.

Protection of Fish and Wildlife

No chemical control of diseases or nematodes should be undertaken unless the expected benefits outweigh possible hazards to other animals. To minimize damage to fish and wildlife, do not use persistent pesticides when alternatives of lesser hazard are available. Select pesticides and methods of application that are least hazardous and apply them at minimum effective dosages.

Avoid drift of pesticides as much as possible and limit applications of pesticides to the target area. To prevent damage to fish, birds, and other animals, be careful not to contaminate streams, lakes, marshes, and grazing or browsing areas by improper application or excessive drift of pesticides. Where drift is difficult to control, use sprays or granules instead of dusts, and ground applications instead of air applications.

Field borders, hedgerows, ditchbanks, stream margins, and wood edges are prime wildlife habitats. Insofar as feasible, avoid treating them. "Dressing the field margins" can be very hard on desirable animal life. Be careful to avoid leaving treated seed or pesticide granules on the surface; this is especially necessary at turnrows. Overlapping swaths of pesticides are dangerous in doubling or tripling the danger to wildlife. This danger is greatest near aerial turning points, where several swaths may overlap, if care is not taken to prevent it.

All pesticide solutions should be mixed with the intent of limiting the problem of excess solutions. Pesticide rinse water, unused spray solutions, and other dilute pesticide wastes are best utilized by adding them to spray mixtures and using them as specified by label directions. Concrete disposal pits are an alternative disposal method for dilute pesticide suspensions, but they do require an RCRA (Resource Conservation and Recovery Act) permit in most situations. If one of the above disposal methods is not possible, treat the pesticide waste as you would any surplus pesticide (see Safe Disposal of Surplus Pesticides and Empty Pesticide Containers on page 8).

Avoiding Harmful Residues in or on Food and Feed

Residues in and on food in excess of the established legal tolerances can be avoided by carefully following label directions. Do not exceed recommended application rates. Observe carefully all time restrictions, especially the required interval between the last application and harvest and(or) foraging by livestock.

Avoid drift of pesticide sprays or dust to nearby crops or livestock, especially from applications by aircraft and other power equipment. Do not allow poultry, dairy animals, or meat animals to feed on plants or drink water contaminated by drift of pesticides.

Byproducts from a number of crops treated with pesticides may be safely fed to livestock or poultry if the crops are harvested and fed after the specified waiting period. Before using or recommending a pesticide, read carefully the safety restrictions in the last column of the tables of this handbook and on the pesticide label to determine if agricultural byproducts, such as corn husks, citrus pulp, alfalfa threshings, bagasse, apple pomace, bean and sugarbeet tops, cull potatoes, trimmings from leafy vegetables, and gin waste from cotton, are safe for feeding to dairy animals, poultry, or animals being finished for slaughter.

Residues in and on food are monitored by the U.S. Food and Drug Administration (FDA). Under the authority of the Food, Drug, and Cosmetic Act, as amended, the FDA may seize food in interstate commerce or while held for sale after shipment in interstate commerce if pesticide residues in that food exceed established tolerances. Furthermore, penalties in the form of imprisonment and(or) fines may be brought against any individual who is criminally responsible for residues in excess of established tolerances.

Most combinations, mixtures, and mixed schedules of different chemicals have been omitted. Sulfur and most copper compounds are exempt from the requirement of tolerances, but not from registration requirement. They are usually omitted but are sometimes listed because one or the other is the only chemical treatment available for control of an important disease.

This handbook does not list all registered pesticide uses but rather includes only those pesticides which have been fully evaluated by ARS scientists and considered to be both efficacious and practical.

Registrations of all suggested uses of pesticides in this publication were in effect on January 1, 1986. Registrations of pesticides may change as new information on uses and residues become available. New uses are frequently added to labels and old ones sometimes are deleted or canceled. Because new pesticides and new uses for old ones are being developed constantly, it is important to obtain the latest information from the USDA, the EPA, the State agricultural experiment stations and extension services, or manufacturers of specific products.

Safe Disposal of Surplus Pesticides and Empty Pesticide Containers

Surplus pesticides can best be eliminated by using them in accordance with label directions provided the labeled use patterns are currently legal under Federal, State, and local laws and regulations. If the intended use of a pesticide cannot be accomplished, use one of the following disposal routes: (1) Home and garden use pesticides -- Dispose of by securely wrapping individual containers in several layers of paper and discard in routine municipal solid waste disposal channels. (2) Return to manufacturer or distributor -- See if your local distributor or the pesticide product manufacturer will accept the return of their product. Transportation must be according to all Federal, State, and local laws and regulations. (3) Canceled pesticides -- EPA will accept for safe disposal those pesticides, the registrations of which have been canceled, after first having been suspended. This can usually be accomplished through your local pesticide distributor or the manufacturer. (4) Commercial disposal -- For pesticides that cannot be disposed of by the procedures outlined above, it is strongly recommended that arrangements be made with a licensed waste disposal firm. The disposal and storage of most waste pesticides (those for which no pesticidal use is intended) is regulated by the RCRA (Resource Conservation and Recovery Act), as amended. This act requires a permit be obtained by generators of hazardous wastes in excess of 1 kg/month of highly toxic compounds (defined as having LD_{50} < 50 mg/kg) and 100 to 1000 kg/month for other compounds. These requirements may vary due to State or local laws and(or) changes in RCRA. Further information should be sought from State and local authorities or the RCRA hazardous waste hotline (800-424-9346 in Washington, D.C. 382-3000).

Empty pesticide containers should be segregated into the following categories and disposed of as indicated. (1) Combustible containers (wood, cardboard, and paper) that contained organic or metallo-organic pesticides (except organic mercury, lead, cadmium, or arsenic compounds) -- Dispose of in a pesticide incinerator or bury in a specially designated landfill. Small quantities may be burned in open fields by the user when permitted by State and local regulations, or buried singly by the user in open fields, using guidelines for protection of surface and subsurface water. (2) Noncombustible containers (metal, glass, and plastic) that contained organic or metallo-organic pesticides (except organic mercury, lead, cadmium or arsenic compounds) -- First triple rinse. Preferably, return to manufacturer for recycling. To dispose of, after other measures have been exhausted, first puncture and crush rinsed container, then bury it in a sanitary landfill. Burying of rinsed containers in the field by the pesticide user is generally permissible. Unrinsed containers should be disposed of in a specially designated landfill, or subjected to incineration in a pesticide incinerator. (3) Containers (combustible and noncombustible) that contained inorganic pesticides or organic mercury, lead, cadmium, or arsenic compounds -- First triple rinse and puncture. Dispose of rinsed containers in a sanitary landfill. Because of their persistence, the pesticides that were in these containers are especially hazardous to the environment. Unrinsed containers should be sealed and buried in a specially designated landfill.

TOXICITY

Fungicides and nematicides are potentially toxic to humans and other nontarget organisms. Exposure to this toxicity is reduced considerably through adjustments by the manufacturer to formulation chemistry, formulation type, and active ingredient concentration. The potential for exposure is further reduced by restricted use classifications, user education programs, and label restrictions and precautions. Most toxicity problems result from a failure to follow precautions and directions for use on the label. This handbook summarizes the most efficacious registered use patterns and the most important restrictions and precautions for these use patterns; however, the user is cautioned to read and follow all directions and precautions given on the label of the pesticide product being used.

The toxicity of pesticides is a major factor in determining the tolerances set on food and feed crops as residues remaining at harvest. The tolerance is set at a safe level as determined by data obtained in animal feeding studies. An adequate safety factor is used in translating animal data. However, a tolerance is not established at a level higher than required for the purpose in accordance with good agricultural practice even if the toxicity of the pesticide is so low that a higher tolerance would be safe. Many factors must be considered in selecting a pesticide for a specific purpose. Whenever possible, always give preference to pesticides that have low toxicity, persist only a short time, and do not accumulate in animal tissues.

Note: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Environmental Protection Agency, consult your county agricultural or State extension specialist to be sure the intended use is still registered.

EXPLANATION OF TABLES AND TERMINOLOGY IN PLANT DISEASE AND NEMATODE SECTIONS

This handbook has two sections of tables. One lists suggested fungicides for the major plant diseases and includes seed treatments. The second contains suggested nematicides to control nematode pests of crop plants, including ornamentals and turf. All chemicals suggested for use are registered for such use by the Environmental Protection Agency. The tables in each section contain a number of terms relating to safety levels, the minimum time that must be allowed from last application of the suggested dosages to harvest or feeding, pesticide formulations, suggested dosage, and brief instructions on where and when to apply these chemicals.

Safety information, precautions, or restrictions on the specific use of certain fungicides and nematicides are given in the last column of the tables. Always read these precautions or restrictions to see if any of them apply to the pesticide that you plan to use and then observe those that are appropriate.

With a few exceptions, the crops and pesticides are listed alphabetically within crop groups. The Fungicide Index, pp. 13 to 24, and the Nematicide Index, pp. 200 to 203, identify the pesticides suggested for use in this handbook. When two or more pesticides are listed for the control of a disease or nematode, they are alternative pesticides and are to be used separately unless mixtures of two or more materials are indicated--usually by plus (+) signs. A single entry in a box applies to all the pesticides and formulations opposite that box, except as specified. A dash or a blank in any column indicates that there is no appropriate entry.

"Formulation" refers to the form of the pesticide, usually as purchased. These materials, with the abbreviations used for them in this guide, are as follows:

D	Dust
EC	Emulsifiable Concentrate
F	Flowable
FL	Flowable Liquid
FS	Flowable Suspension
G	Granules
L	Liquid
LC	Liquid Concentrate
SL	Slurry
WP	Wettable Powder

The pesticide treatment rates given in this guide usually include the maximums suggested for plant disease and nematode control. Concentrations can often be reduced without loss in effectiveness. Effective concentrations also can be reduced by careful attention to application techniques or by using highly efficient well-maintained equipment under favorable weather conditions. Treatment rates suggested on registered labels should not be exceeded to avoid illegal residues on harvested products.

Toxicity data are tabulated for fungicides on page 25 and for nematicides on pages 204 and 205. The LD_{50} value is a statistical estimate of the dosage necessary to kill 50 percent of a population of white rats or other test animals within a standard time period under standard laboratory conditions. An acute LD_{50} value indicates toxicity resulting from a single exposure. Acute oral (AO) values indicate introduction of the chemicals into the animal's esophagus or stomach; acute dermal (AD) values indicate placement of the chemicals directly on the skin. The numerical value is the amount of toxicant, in milligrams (mg), for each kilogram (kg) of body weight of the exposed animals. Acute vapor values shown for several of the fumigant nematicides are those concentrations, in parts per million (p/m), that are probably not dangerous to human life for 60 minutes. Chronic vapor values are those concentrations, in p/m, that are at the human threshold of toxic exposure for 5 days a week, 8 hours a day. The toxicity of a chemical to laboratory animals may vary, however, with species, age, sex, and nutritional state, and with the formulation of the pesticide and the manner of administration. Also, the acute LD_{50} value may provide little or no information on possible cumulative effects of repeated dosages of a chemical.

Trade names are used in this handbook solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture.

METRIC SYSTEM EQUIVALENTS

A list of metric equivalents for weight, volume, and area units, and linear dimensions used in all of the tables are as follows:

Length

Centimeter	=	0.3937 inch
Meter	=	3.23 feet
Kilometer	=	0.621 statute mile
Kilometer	=	0.5396 nautical mile
Inch	=	2.540 centimeters (or 1000 mils)
Foot	=	30.48 centimeters
Yard	=	0.914 meter
Rod (16.5 feet)	=	5.029 meters
Statute mile (1,760 yards)	=	1.61 kilometers

Area

Hectare	=	2.471 acres
Acre (43,560 square feet)	=	0.405 hectare

Volume

Liter	=	1.05 quarts, U.S.
Quart, liquid, U.S. (32 ounce)	=	0.946 liter
Quart, imperial (40 ounce)	=	1.136 liters
Gallon, U.S. (4 quarts)	=	3.785 liters
Gallon, imperial	=	4.546 liters

Weight

Gram	=	0.035 Avoirdupois ounces
Kilogram	=	2.205 Avoirdupois pounds
Metric ton	=	0.984 gross or long ton
Metric ton	=	1.102 short or net tons
Avoirdupois pound (16 ounces)	=	0.4536 kilogram
Avoirdupois ounce	=	28.35 grams
Ounce (British Fluid)	=	28.41 ml
Ounce (U.S. Fluid)	=	29.57 ml
Gross or long ton (2240 pounds)	=	1.016 metric tons
Short or net ton (2000 pounds)	=	0.907 metric ton

Other conversions

Square inch	=	6.45 square centimeters
Pound per square inch	=	70.31 grams per square centimeter
30 pounds per square inch	=	2.11 kilograms per square centimeter
Pound per acre	=	1.12 kilograms per hectare
Gallon per acre	=	9.35 liters per hectare
Pound per gallon	=	0.12 kilograms per liter
Foot candle	=	10.764 lux

INTRODUCTION TO PLANT DISEASE SECTION

The 10 tables listing the various crops and diseases, pages 41-194, are arranged in the following order: Field Crop Diseases, Flower and Ornamental Diseases, Fruit Diseases, Fruit and Vegetable Postharvest Diseases, Grass Seed Crop Diseases, Oilseed and Industrial Crop Diseases, Shade Tree Diseases, Tree-Nut Diseases, Turfgrass Diseases, and Vegetable Diseases. For an explanation of these tables, see page 10 of this guide. Each table begins with controls other than chemical, termed "Alternative Control Measures." These are followed by the fungicides suggested for control of the various diseases, namely those which through general usage have been found to provide adequate to excellent control when used in accordance with the recommendations made by local or regional plant pathologists.

In several instances, the suggested chemicals are intended to be used for the control of bacterial diseases. The chemicals suggested for control of a particular disease are not given in order of priority, nor is the list necessarily exhaustive. All chemicals suggested for use are registered for such use by the Environmental Protection Agency. Only diseases that are considered to be of major economic importance are given in the tables. In most cases, these diseases have been identified not only by common name, such as "wilt," "rot," and "leaf spot," but also by the scientific name of the agent causing the disease. Such specific identification will help clarify some of the confusion that has existed in the past because of the use of purely descriptive but otherwise meaningless terms, such as "wilt," "rot," and leaf spot."

This handbook does not list all registered pesticide uses but rather includes only those pesticides which have been fully evaluated by ARS scientists and considered to be both efficacious and practical.

ALWAYS CONSULT PRODUCT LABEL BEFORE USE

FUNGICIDE INDEX

Material[1]	Chemical Name[2] (and additional designations)
AC 5223	see dodine
Acti-dione®	see cycloheximide
Agri-mycin®17	see streptomycin sulfate
Agri-Strep®	see streptomycin sulfate
Allisan®	see DCNA
ammoniacal copper complex	see copper-ammonium complex
anilazine	2,4-dichloro-6-(o-chloroanilino)-s-triazine (Dyrene®, B-622)
Anticarie	see hexachloro=benzene
Apron®	see metalaxyl
Arasan®	see thiram
Arbotect™ 20-S	see thiabendazole hypophosphite
B-622	see anilazine
Banol™	see propamocarb hydrochloride
Banrot®	see thiophanate-methyl + etridiazole
BAY 22555	see fenaminosulf
Bayleton™	see triadimefon
BAY MEB 6447	see triadimefon
Bed Fume®	see MBR
Benlate®	see benomyl
benomyl	methyl 1-(butylcar=bamoyl)-2-benzimid=azolecarbamate (Benlate®, Tersan® 1991, Fungicide 1991)
biphenyl	biphenyl (diphenyl)
blue stone	see copper sulfate
borax	sodium tetraborate decahydrate
bordeaux mixture	mixture of copper sulfate solution with suspension of calcium hydroxide
Botran®	see DCNA
Bravo®500	see chlorothalonil
Bravo® W-75	see chlorothalonil
Brom-O-Gas®	see MBR
Busan®72	see TCMTB

Material[1]	Chemical Name[2] (and additional designations)
sec-butylamine	2-aminobutane (Tutane®)
Caddy	see cadmium chloride
Cadminate®	see cadmium succinate
cadmium chloride	cadmium chloride (Caddy)
cadmium sebacate, potassium chromate, malachite green, auramine, thiram	cadmium sebacate 5.0%, potassium chromate 5.0%, malachite green 1.0%, auramine 0.5%, thiram 16% (total cadmium 1.6%, total chromium 1.3%) (Kromad®)
cadmium succinate	cadmium succinate (Cadminate®)
calcium chloride	calcium chloride
calcium hypochlorite	calcium hypochlorite (Magnum™)
captafol	cis-N-[(1,1,2,2-tetrachloroethyl)=thio]-4-cyclohexene-1,2-dicarboximide (Difolatan®, Ortho 5865)
captan	N-[(trichloromethyl)=thio]-4-cyclohexene-1,2-dicarboximide (Orthocide®, SR-406)

Material[1]	Chemical Name[2] (and additional designations)
carboxin	5,6-dihydro-2-methyl-1,4-oxathiin-3-car=boxanilide (Vitavax®, D-735)
Cercobin®	see thiophanate
Cercobin-M®	see thiophanate-methyl
CGA-48988	see metalaxyl
CGA-64250	see propiconazol
CGA-64251	see propiconazol
Chinosol®	see 8-quinolinol sulfate
Chipco®26019	see iprodione
chloroneb	1,4-dichloro-2,5-dimethoxybenzene (Demosan®, Soil Fungicide 1823, Tersan® SP)
chloropicrin	trichloronitro=methane (Picfume®, Larvacide®)
chlorothalonil	tetrachloroisophthal-onitrile (Bravo®500, (Bravo® W-75, DAC 2787, Daconil 2787®, Termil®)

Material[1]	Chemical Name[2] (and additional designations)
Citcop 4E	see copper salts of fatty and rosin acids
Cleary 3336	see thiophanate
C-O-C-S®	see copper oxychloride sulfate
copper ammonium carbonate	copper ammonium carbonate (Copper-Count®N, Oxycop®8L)
copper-ammonium complex	copper-ammonium complex (ammoniacal copper complex)
Copper-Count®N	see copper ammonium carbonate
copper, fixed	see fixed copper
copper carbonate	copper carbonate (malachite)
copper hydroxide	cupric hydroxide (Kocide®101)
copper oxychloride sulfate	basic copper sulfate and chlorides (C-O-C-S®)
copper salts of fatty and rosin acids	copper salts of fatty and rosin acids (Citcop 4E)

Material[1]	Chemical Name[2] (and additional designations)
copper sulfate	copper sulfate, pentahydrate (blue stone)
copper sulfate (basic)	see fixed copper
copper sulfate (monohydrate) + excess of hydrated lime	forms bordeaux mixture in presence of moisture on plant surface
copper-zinc sulfate complex	copper-zinc sulfate complex
CR-1639	see dinocap
Crag® Glyodin	see glyodin
cycloheximide	3-[2-(3,5-dimethyl-2-oxocyclohexyl)-2-hydroxyethyl]glutarimide (Acti-dione®)
Cyprex®	see dodine
2,4-D	(2,4-dichlorophenoxy)acetic acid (Weedone®638)
D-735	see carboxin
DAC 2787	see chlorothalonil
Daconil 2787®	see chlorothalonil

Material[1]	Chemical Name[2] (and additional designations)
DCNA	2,6-dichloro-2-nitroaniline (Botran®, Allisan®, U-2069, RD-6584, dicloran)
DD-MENCS	1:1 mixture of 1,2-dichloropropane and 1,3-dichloropropene and related chlorinated C_3 hydrocarbons (80%) + methyl isothiocyanate (20%) (Vorlex®)
dehydro acetic acid (sodium salt)	dehydro acetic acid, sodium salt (sodium dehydroacetate)
Demosan®	see chloroneb
Dexon®	see fenaminosulf
dichlone	2,3-dichloro-1,4-naphthoquinone (Phygon®)
dicloran	see DCNA
Difolatan®	see captafol
Dikar®	see dinocap + mancozeb
dinocap	2-(1-methylheptyl)-4,6-dinitrophenyl crotonate (commercial product is a reaction mixture containing several isomers) (Karathane®, CR-1639)
dinocap + mancozeb	coordination product of zinc ion and manganous ethylenebis [dithiocarbamate] + 2-(1-methylheptyl)-4,6-dinitrophenyl crotonate (commercial product is a reaction mixture containing several isomers) (Dikar®)
diphenyl	see biphenyl
diphenylamine	diphenylamine (DPA)
Dithane® M-22	see maneb
Dithane® M-22 Special	see maneb-zinc
Dithane® M-45	see mancozeb
Dithane® S-31	see nickel sulfate-maneb
Dithane® Z-78	see zineb
DMDT	see methoxychlor
dodemorph acetate	4-cyclodecyl-2,6-dimethylmorpholinium acetate (Milban®)
dodine	*n*-dodecylguanidine acetate (Cyprex®, Melprex®, AC 5223)
Dowicide® G	see sodium pentachlorophenate

Material[1]	Chemical Name[2] (and additional designations)
Dowicide™ 1	see OPP
DPA	see diphenylamine
Du-Ter®	see fentin hydroxide
Dyrene®	see anilazine
EL-211	see piperalin
EL-222	see fenarimol
EL-273	see triarimol
ethoxyquin	6-ethoxy-1,2-dihydro-2,2,4-trimethylquinoline (Santoquin®, Stop-Scald®)
ETMT	see etridiazole
etridiazole	5-ethoxy-3-(trichloromethyl)-1,2,4-thiadiazole (Koban®, OM 2424, Terraclor Super-X® (in part), Terrazole®, Truban® ETMT)
F-461	see oxycarboxin
fenaminosulf	sodium *p*-(dimethylamino)benzenediazosulfonate (Dexon®, BAY 22555, Lesan®)
fenarimol	α-(2-chlorophenyl)-α-(4-chlorophenyl)-5-pyrimidinemethanol (EL-222, Rubigan®)
fentin hydroxide	triphenyltin hydroxide (Du-Ter®, TPTH)
ferbam	ferric dimethyldithiocarbamate (Fermate®, Karbam® Black, Naco Hi-Test ferbam)
Fermate®	see ferbam
fixed copper	includes the basic sulfates, oxychlorides, and oxides
folpet	*N*-[(trichloromethyl)thio]phthalimide (Phaltan®)
folpet-cadmium carbonate-thiram	folpet 60%, cadmium carbonate 5%, thiram 10% (Ortho® Lawn and Turf Fungicide)
Fore®	see mancozeb
formaldehyde	formaldehyde (methanal, formalin)
formalin	see formaldehyde
Fungicide 1991	see benomyl

Material[1]	Chemical Name[2] (and additional designations)
Funginex®	see triforine
Fungo®50	see thiophanate-methyl
glyodin	2-heptadecyl-2-imidazoline acetate (Crag® Glyodin)
HCB	see hexachlorobenzene
hexachlorobenzene	hexachlorobenzene (Anticarie, HCB, No Bunt 40, No Bunt Liquid, perchlorobenzene)
8-hydroxyquinoline sulfate	see 8-quinolinol sulfate
iprodione	3-(3,5-dichlorophenyl)-*N*-(1-methylethyl)-2,4-dioxo-1-imidazolidinecarboxamide (Rovral®, Chipco® 26019, Proturf® Fungicide VI)
Karathane®	see dinocap
Karbam® Black	see ferbam
Koban®	see etridiazole
Kocide®101	see copper hydroxide
Kromad®	see cadmium sebacate potassium chromate, malachite green, auramine, thiram
Lanstan®	see NIA 5961
Larvacide®	see chloropicrin
Lesan®	see fenaminosulf
Lignasan® BLP	see MBC phosphate
lime-sulfur	30% calcium polysulfide and various small amounts of calcium thiosulfate plus water and free sulfur
Magnum™	see calcium hypochlorite
malachite	see copper carbonate
mancozeb	coordination product of zinc ion and manganous ethylenebis[dithiocarbamate] (Dithane® M-45, Fore®, Manzate®200, zinc ion-maneb complex)
maneb	manganous ethylenebis[dithiocarbamate] (Dithane® M-22, Manzate®, MEB, Tersan® LSR)
maneb-zinc	manganous ethylenebis[dithiocarbamate] and zinc (Dithane® M-22 Special, Manzate® D)

Material[1]	Chemical Name[2] (and additional designations)
Manzate®	see maneb
Manzate® D	see maneb-zinc
Manzate®200	see mancozeb
Marlate®	see methoxychlor
MBC phosphate	methyl 2-benzimid=azolecarbamate phosphate (Lignasan® BLP)
MBR	monobromomethane or methyl bromide (Bed Fume®, Brom-O-Gas®, Meth-O-Gas®, Panobrome®, Pestmaster®, Weedfume®)
MEB	see maneb
Melprex®	see dodine
Mertect®	see thiabendazole
metalaxyl	N-(2,6-dimethyl=phenyl)-N-(methoxy=acetyl)alanine methyl ester (Apron®, CGA-48988, Ridomil®, Subdue®)
methanal	see formaldehyde
Meth-O-Gas®	see MBR
methoxychlor	1,1,1-trichloro-2,2-bis(p-methoxyphenyl)=ethane (Marlate®, DMDT)
methyl bromide	see MBR
methylene chloride	methylene chloride
MF-509	see thiophanate-methyl
Milban®	see dodemorph acetate
Mildothane®	see thiophanate-methyl
nabam	disodium ethylene=bis(dithiocarbamate) (Spring-Bak®)
Naco Hi-Test ferbam	see ferbam
NF 35	see thiophanate
NF 44	see thiophanate-methyl
NIA 5961	1-chloro-2-nitro=propane (Lanstan®)
NIA 9102	mixture of 5.2 parts by weight of ammoniates of [ethylene=bis(dithiocarbamato)]=zinc with 1 part by weight ethylenebis=[dithiocarbamic acid], bimolecular and trimolecular cyclic anhydrosulfides and disulfides (Polyram®)

Material[1]	Chemical Name[2] (and additional designations)
Niagara Z-C® Spray	see ziram
nickel sulfate-maneb	mixture of nickel sulfate and manganous ethylenebis[dithiocarbamate] (Dithane® S-31)
No Bunt 40	see hexachlorobenzene
No Bunt Liquid	see hexachlorobenzene
OM 2424	see etridiazole
OPP	o-phenylphenol (Dowicide™1)
Ornalin™	see vinclozolin
Ortho 5865	see captafol
Orthocide®	see captan
Ortho® Lawn and Turf Fungicide	see folpet-cadmium carbonate-thiram
oxine sulfate	see 8-quinolinol sulfate
oxycarboxin	5,6-dihydro-2-methyl-1,4-oxathiin-3-carboxanilide 4,4-dioxide (Plantvax®, F-461)
Oxycop®8L	see copper ammonium carbonate

Material[1]	Chemical Name[2] (and additional designations)
Panobrome®	see MBR
paraformaldehyde	paraformaldehyde (polymerized formaldehyde, trioxymethylene)
Parzate® C	see zineb
Parzate® D	see zineb
PCNB	pentachloronitrobenzene (Terrachlor®, Terraclor®, Terraclor Super-X® (in part), quintozene)
PCNB-etridiazole	pentachloronitrobenzene + 5-ethoxy-3-(trichloromethyl)-1,2,4-thiadiazole (Terraclor Super-X®)
perchlorobenzene	see hexachlorobenzene
Pestmaster®	see MBR
Phaltan®	see folpet
Phygon®	see dichlone
Picfume®	see chloropicrin
piperalin	3-(2-methylpiperidino)propyl 3,4-dichlorobenzoate (Pipron®, EL-211)

Material[1]	Chemical Name[2] (and additional designations)
Pipron®	see piperalin
Plantvax®	see oxycarboxin
polymerized formaldehyde	see paraformaldehyde
Polyram®	see NIA 9102
Prevex™	see propamocarb hydrochloride
propamocarb hydrochloride	propyl [3-(dimethylamino)propyl]carbamate monohydrochloride (Banol™, Prevex™)
propiconazol	1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxalan-2-yl]methyl]-1*H*-1,2,4-triazole (Tilt®, CGA-64250, CGA-64251, Vangard®)
Proturf® Fungicide VI	see iprodione
8-quinolinol sulfate	8-quinolinol sulfate (Chinosol®, oxine sulfate, Quinosol®, 8-hydroxyquinoline sulfate)
Quinosol®	see 8-quinolinol sulfate
quintozene	see PCNB
RD-6584	see DCNA
Ridomil®	see metalaxyl
Ronalin™	see vinclozolin
Rovral®	see iprodione
Rubigan®	see fenarimol
Santobrite	see sodium pentachlorophenate
Santoquin®	see ethoxyquin
Saprol®	see triforine
sodium dehydroacetate	see dehydro acetic acid (sodium salt)
sodium dimethyldithiocarbamate	sodium dimethyldithiocarbamate
sodium hypochlorite	sodium hypochlorite
sodium pentachlorophenate	sodium pentachlorophenate (Dowicide® G, Santobrite)
Soil Fungicide 1823	see chloroneb
SOPP	sodium *o*-phenylphenate
Spot-Kleen	see thiophanate-methyl
Spotrete	see thiram
Spring-Bak®	see nabam

Material[1]	Chemical Name[2] (and additional designations)
SR-406	see captan
Stop-Scald®	see ethoxyquin
streptomycin sulfate	2,4-diguanidino-3,5,6-trihydroxycyclohexyl 5-deoxy-2-O-(2-deoxy-2-methylamino-α-glucopyranosyl)-3-formyl-β-L-lyxopentanofuranoside (Agri-mycin® 17, Agri-Strep®)
Subdue®	see metalaxyl
sulfur	sulfur
TCMTB	2-[(thiocyanomethyl)thio]benzothiazole (Busan®72)
TD-1604	see thiophanate
TD-1771	see thiophanate-methyl
Tecto®	see thiabendazole
Termil®	see chlorothalonil
Terrachlor®	see PCNB
Terraclor®	see PCNB
Terraclor Super-X®	see PCNB-etridiazole
Terrazole®	see etridiazole
Tersan®	see thiram
Tersan®1991	see benomyl
Tersan® LSR	see maneb
Tersan® SP	see chloroneb
tetraiodoethylene	tetraiodoethylene
thiabendazole	2-(4-thiazolyl)benzimidazole (Mertect®, Tecto®)
thiabendazole hypophosphite	2-(4-thiazolyl)benzimidazole hypophosphite (Arbotect™ 20-S)
thiophanate	diethyl [(1,2-phenylene)bis(iminocarbonothioyl)]bis[carbamate] (Cercobin®, Cleary 3336, NF 35, TD-1604, Topsin®)
thiophanate-methyl	dimethyl [(1,2-phenylene)bis(iminocarbonothioyl)]bis[carbamate] (Cercobin-M®, Fungo®50, MF-509, Mildothane®, NF 44, Spot-Kleen, TD-1771, Topsin-M®)

Material[1]	Chemical Name[2] (and additional designations)
thiophanate-methyl + etridiazole	dimethyl [(1,2-phenylene)bis(iminocarbonothioyl)]bis[carbamate] + 5-ethoxy-3-(trichloromethyl)-1,2,4-thiadiazole (Banrot®)
thiram	bis(dimethylthiocarbamoyl)disulfide (Arasan®, Spotrete, Tersan®, Thiramad®, Thylate®, TMTD, TMTDS)
Thiramad®	see thiram
Thylate®	see thiram
Tilt®	see propiconazol
TMTD	see thiram
TMTDS	see thiram
Topsin®	see thiophanate
Topsin-M®	see thiophanate-methyl
TPTH	see fentin hydroxide
triadimefon	1-(4-chlorophenoxy)-3,3-dimethyl-1-(1H-1,2,4-triazol-1-yl)-2-butanone (BAY MEB 6447, Bayleton™)

Material[1]	Chemical Name[2] (and additional designations)
triarimol	α-(2,4-dichlorophenyl)-α-phenyl-5-pyrimidinemethanol (E1-273)
triforine	N,N'-[1,4-piperazinediylbis(2,2,2-trichloroethylidene)]bis[formamide] (Funginex®, Saprol®)
trioxymethylene	see paraformaldehyde
Truban®	see etridiazole
Tutane®	see sec-butylamine
U-2069	see DCNA
Vangard®	see propiconazol
vinclozolin	3-(3,5-dichlorophenyl)-5-ethenyl-5-methyl-2,4-oxazolidinedione (Ornalin™, Ronalin™, Vorlan™)
Vitavax®	see carboxin
Vorlan™	see vinclozolin
Vorlex®	see DD-MENCS
Weedfume®	see MBR

Material[1]	Chemical Name[2] (and additional designations)
Weedone®638	see 2,4-D
Zerlate®	see ziram
zinc ion-maneb complex	see mancozeb
zinc sulfate	zinc sulfate
zineb	zinc ethylenebis[dithiocarbamate] (Dithane® Z-78, Parzate® C, Parzate® D)
ziram	zinc dimethyldithiocarbamate (Niagara Z-C® Spray, Zerlate®)

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[1] An ® after the name indicates a registered trade name. A ™ after the name indicates a trademark. Common names are used when available and are usually in lower case. In the left-hand column, the name underscored is the name used in this publication.

[2] A chemical name occupying 2 lines separated by an equal (=) sign is joined together without any separation if written on 1 line.

TOXICITY TABLE

Acute oral LD$_{50}$ values of fungicides for test animals

Fungicide	AO LD$_{50}$[1] (mg/kg)
anilazine	2,710
benomyl	[2]>9,590
biphenyl	3,280
borax	2,660-5,140
bordeaux mixture	300
cadmium chloride	88
cadmium succinate	660
calcium hypochlorite	(rb) chlorine LC 0.4-0.9
captafol	5,000
captan	9,000
carboxin	3,200
chloroneb	11,000
chloropicrin	[3]0.8 mg/L
chlorothalonil	>10,000
cycloheximide	2.5
2,4-D	375
DCNA	4,040
DD-MENCS (MENCS fraction only)	100
dichlone	1,300
dinocap	980
diphenylamine	>2,500
dodine	1,000
etridiazole	2,000
fenaminosulf	60
fentin hydroxide	108
ferbam	>17,000
folpet	>10,000
formaldehyde	800
glyodin	3,720
hexachlorobenzene	10,000
mancozeb	>8,000
maneb	6,750
nabam	395
NIA 5961	197
NIA 9102	6,400
nickel sulfate-maneb	2,780
OPP	2,400
oxycarboxin	2,000
paraformaldehyde	>1,600
PCNB	1,650
8-quinolinol sulfate	1,200
sodium pentachlorophenate	210
SOPP	2,480
streptomycin sulfate	(m) 9,000
TCMTB	1,590
thiabendazole	3,330
thiram	375
zineb	>5,200
ziram	1,400

See footnotes at end of table.

[1] Acute oral (AO) levels expressed as LD$_{50}$ values for white rats except for rabbit (rb) and white mouse (m).

[2] This is approximate lethal dose.

[3] This is lethal dose for 30-minute exposure.

SEED TREATMENT LISTS

These lists are alphabetized according to the common name of the fungicide. Crops are alphabetized in each list and method of application and dosage rate are given opposite each crop.

Captan Seed Treatments[a]

Crop	Dosage rate for -		
	Slurry method of application	Dry method of application	Planter box application
	Oz act./100 lb	Oz act./100 lb	Oz act./100 lb
Alfalfa	2.2 -4.13	6.0	0.4
	[b]4.2	[b]6.0	---
Barley	0.6 -1.9	0.6 -2.0	0.8 -2.0
	[c]1.5 -3.6	[d]0.8	[d]0.8 -2.4
	[b]1.0	[b]1.1	[c]1.5 -3.6
	[e]1.94	---	[f]0.8 -1.2
	[g]0.21	[g]0.21	[g]0.21
Bean	0.8 -1.5	1.5 -1.9	0.2 -1.0
	[b]1.3	[b]1.8	[d]1.0 -2.0
	[c]1.25-3.0	---	3.2 -6.3 oz/ acre
	[e]1.08	---	[c]1.25-2.5
	---	---	[f]0.66-1.0
Bean, lima	[e]1.61	---	---
Beet, sugar	0.6 -9.6	0.6 -9.0	---
	[b]3.1	[b]1.32	---
Beet, table	3.4 6.0	9.0	---
	[b]6.0	[b]8.8	---

See footnotes at end of table.

Captan Seed Treatments[a] -- con.

Crop	Dosage rate for -		
	Slurry method of application	Dry method of application	Planter box application
	Oz act./100 lb	Oz act./100 lb	Oz act./100 lb
Bluegrass	2.2 -4.13	6.0	---
	[b]4.2	[b]6.0	---
Broccoli	0.4 -2.25	1.13-1.80	---
Brussels sprouts	0.4 -2.25	1.13-1.80	---
Cabbage	0.4 -2.25	1.13-1.80	0.4
Cantaloup	1.15-1.6	1.50-2.25	0.8
	[h]1.5	[h]1.5	---
	[b]1.54	[b]2.2	---
Carrot	4.5	6.75	---
Cauliflower	0.4 -2.25	1.3 -1.8	0.4
Clover	2.2 -4.13	6.0	0.4
	[b]4.2	[b]6.0	---
Collards	0.4	---	---
Conifers (Douglas-fir,.. Red pine, Scotch pine, Norway spruce)	---	1.5	---
Corn, field	0.5 -1.2	0.8 -1.7	1.6 -1.8
	[b]0.9	[b]0.9	[d]1.07-2.14
	[e]1.13	---	---
	[c]1.35-3.21	---	[c]1.35-3.21
	---	---	[f]0.66-1.08

See footnotes at end of table.

Captan Seed Treatments[a] -- con.

Crop	Dosage rate for -		
	Slurry method of application	Dry method of application	Planter box application
	Oz act./100 lb	Oz act./100 lb	Oz act./100 lb
Corn, sweet	0.8 -2.0	1.5 -1.9	---
	[e]2.10-3.75	---	---
Cotton	0.75-4.0	1.13-2.70	---
	[b]0.9 -2.2	[b]1.1 -3.1	[i]4.0 -4.8 oz/acre
	[j]3.0	[j]3.0	[d]0.6 -1.2
	---	---	3.2 -6.4 oz/acre
	---	---	[k]4.8 oz/acre
Crucifers	0.4 -1.8	1.13-1.80	0.4
	[b]0.8	[b]1.1	---
Cucumber	0.7 -1.6	1.50-2.25	0.8
	[h]1.5	[h]1.5	---
	[b]1.5	[b]2.2	---
Eggplant	3.0	4.5	---
Flax	1.0 -1.9	1.5 -2.7	---
	---	[d]1.6	---
	[b]1.8	[b]2.2	---
	[g]0.37	[g]0.37	[g]0.37
Grasses	2.2 -9.0	6.0	---
Kale	0.4	---	---
Legumes, small-seeded ..	---	6.0	---

See footnotes at end of table.

Captan Seed Treatments[a] -- con.

Crop	Dosage rate for -		
	Slurry method of application	Dry method of application	Planter box application
	Oz act./100 lb	Oz act./100 lb	Oz act./100 lb
Lentil	1.32	---	---
Lespedeza	2.2 -4.13	6.0	---
Millet	[e]2.15	---	---
Milo	2.0 -3.0	3.0	0.8
	[g]0.18	[g]0.18	[g]0.18
Muskmelon	0.5 -1.0	1.5	---
Mustard	0.4 -2.25	0.3 -10.0	---
Oats	0.6 -2.8	0.6 -3.0	0.4 -2.0
	[c]2.25-5.63	[d]2.4	[d]1.88-3
	[b]1.5	[b]1.65	[c]2.25-5.63
	---	---	[f]1.2 -1.8
	[g]0.31	[g]0.31	[g]0.31
Onion (pelleting)	---	0.75-1.00 lb /lb seed	4.0 oz/lb
Pea, blackeye	0.8 -1.5	2.25	---
	[b]1.3	[b]1.8	---
	[e]1.08	---	---
Pea, garden and field	0.8 - 1.8	1.8 -1.9	0.8 - 1.0
	[b]1.28	[b]1.8	[d]1.0 -2.0
	[c]1.25-3.0	---	[c]1.25-3.0
	[e]1.61	---	[f]0.66-1.08

See footnotes at end of table.

Captan Seed Treatments[a] -- con.

Crop	Dosage rate for -		
	Slurry method of application	Dry method of application	Planter box application
	Oz act./100 lb	Oz act./100 lb	Oz act./100 lb
Peanut, shelled	---	1.0 -6.0	1.0 - 3.0
	---	[l]0.75-1.125	[l]0.75-1.125
	---	[m]1.2 -2.25	[d]4.0
	---	[c]1.5 -2.25	[c]0.75-2.25
	---	[e]1.94	[f]0.4 -0.6
		[n]1.8	
Peanut, unshelled	3.0	1.72	---
Pepper	0.8 -1.5	2.25	---
	[b]1.54	[b]2.2	---
Pumpkin	0.5 -1.8	1.5 -1.8	---
	[h]1.5	[h]1.5	---
	[b]1.0	[b]1.54	---
Radish	0.75	1.125	---
Rice	0.9 -3.75	0.80-3.75	2.0 -3.5
Rutabaga	2.25	3.375	---
Rye	0.6 -1.6	0.6 -1.5	---
	[c]1.35-3.21	[d]0.8	[d]1.07-2.14
	---	---	[c]1.35-3.2
	---	---	[f]0.66-1.0
	[g]0.18	[g]0.18	[g]0.18
Safflower	[e]1.94	0.3	---
Sesame	0.75-1.0	---	---
	[e]1.61	---	---

See footnotes at end of table.

Captan Seed Treatments[a] -- con.

Crop	Dosage rate for -		
	Slurry method of application	Dry method of application	Planter box application
	Oz act./100 lb	Oz act./100 lb	Oz act./100 lb
Sorghum	0.8 -2.3	1.0 -3.0	0.5 -2.0
	[b]1.54	[b]1.65	[k]2.4
	[e]2.15	---	---
	[g]0.18	[g]0.18	[g]0.18
Soybeans	0.7 -1.3	0.8 -2.0	0.4 -1.75
	[b]1.28	[b]1.8	[d]1.0 -2.0
	[c]1.34-3.0	---	[c]1.25-3.0
	[e]1.08	---	[f]0.66-1.0
	---	---	[k]1.5
Spinach	1.8 -3.0	4.5	---
	[b]3.1	[b]4.4	---
Squash	0.5 -1.8	1.5 -1.8	0.8
	[h]1.5	[h]1.5	---
	[b]1.0	[b]1.54	---
Sugarbeet	(See Beet, sugar)		
Sunflower	---	0.5	---
Swiss chard	3.4 -6.0	9.0	---
Tomato	0.8	---	---
Trefoil	2.2 -4.13	6.0	---
Turnip	0.4 -1.5	2.25	---

See footnotes at end of table.

Captan Seed Treatments[a] -- con.

Crop	Dosage rate for -		
	Slurry method of application	Dry method of application	Planter box application
	Oz act./100 lb	Oz act./100 lb	Oz act./100 lb
Watermelon	0.5 -1.5	1.25-1.50	0.8
	[h]1.5	[h]1.5	---
	[b]1.0	[b]1.54	---
Wheat	0.6 -2.0.	0.6 -1.5	0.4 -2.0
	[e]1.72	[d]0.33	[d]1.0 -2.0
	[o]1.25	[o]0.7 -1.25	[o]0.7 -1.25
	[b]0.825	[b]0.9	[c]1.25-3.0
	[c]1.34-3.0	---	[f]0.66-1.0
	---	---	[k]1.25
	[g]0.83	[g]0.83	[g]0.83

---

[a] Do not use treated seed for food, feed, or oil.
[b] In combination with zineb (captan to zineb ratio of 22:21).
[c] In combination with equal amounts of maneb.
[d] In combination with equal amounts of HCB and maneb.
[e] In combination with equal amounts of thiram.
[f] In combination with maneb (maneb to captan ratio of 3.5:1).
[g] In combination with HCB and maneb (captan to HCB to maneb ratio of 1:4:7).
[h] In combination with 2.1 oz actual thiram/100 lb.
[i] In combination with equal amounts of folpet.
[j] In combination with equal amounts of carboxin.
[k] In combination with equal amounts of PCNB.
[l] In combination with equal amounts of maneb plus 0.4 to 0.6 oz actual PCNB and 0.1 to 0.15 oz actual etridiazole.
[m] In combination with equal amounts of DCNA.
[n] In combination with 0.6 oz actual DCNA.
[o] In combination with equal amounts of HCB. Also controls stinking smut (bunt).

Chloroneb Seed Treatments[a]

Crop	Dosage rate for-	
	Slurry method of application[b]	Planter box application
	Oz act./ 100 lb	Oz act./ 100 lb
Beans	2.6	3.2
Cotton (acid delinted, reginned or fuzzy)	[c]4.0	8.0
East of Rockies	3.9	---
West of Rockies	6.5	---
Soybeans	2.6	3.2
Sugarbeet	3.9	---

---

[a] Do not use treated seed for food, feed, or oil. Do not graze treated beans or soybeans within 45 days after planting.

[b] May be tank mixed with recommended amounts of thiram.

[c] Used in combination with 2.25 oz actual thiram.

Dichlone Seed Treatments[a]

Crop	Dosage rate for-	
	Slurry method of application	Dry method of application
	Oz act./ 100 lb	Oz act./ 100 lb
Alfalfa	1.5-2.0	1.5-2.0
Beet, table	2.0	2.0
Clover	2.0	4.0
Corn, field	.5	.5
Corn, popcorn and sweet	.75	.75
Legumes, small-seeded	2.0	4.0
Lettuce	2.0	---
Pea	1.0	1.0
Peanut	2.0	---
Pepper	2.0	2.0
Rice	1.0	1.0
Sorghum	1.0	1.0
Spinach	2.0	2.0
Sugarbeet	2.0	2.0
Swiss chard	2.0	2.0
Tomato	2.0	2.0

---

[a] Do not use treated seed for food, feed, or oil.

Fenaminosulf Seed Treatments[a]

Crop/ Diseases and causal organisms	Dosage
	Oz act./ 100 lb
Bean, lima and snap Seed rot and damping-off (*Aphanomyces*, *Pythium*)	0.7
Beet, table Seed rot and damping-off (*Aphanomyces*, *Pythium*)	2.8
Corn Damping-off (*Pythium*)	0.28-0.56
Cotton Anthracnose, damping-off (*Pythium*)	[b]1.4-2.1
Cucumber Seed rot and damping-off (*Pythium*)	2.1
Pea Seed rot and damping-off (*Aphanomyces*, *Pythium*)	0.7
Sorghum Covered kernel smut, damping-off (*Pythium*)	0.7-1.4
Spinach Seed rot and damping-off (*Aphanomyces*, *Pythium*)	2.8
Sugarbeet Seed rot and damping-off (*Aphanomyces*, *Pythium*)	[c]1.4-4.2

---

[a] Do not use treated seed for food, feed, or oil. Application to sugarbeet by slurry only; all other treatments may be applied by dry mixing or by slurry.

[b] Use highest rate only if adequate soil moisture is present to avoid possible injury to seedlings. Also used in combination with chlorothalonil.

[c] Do not exceed 2.8 oz actual on seed to be planted in light soils.

Hexachlorobenzene (HCB) Seed Treatments[a]

Crop	Diseases	Dosage[b]
Onion, pelleted (Washington State)	Smut	0.4 lb/1.0 lb seed
Sorghum (Colorado)	Covered kernel smut, seedling blight	0.32 to 0.40 oz act. as a slurry or machine dust; dust; 0.53 oz act. as farm-applied dust; or 0.75 oz act. by automatic machine/bu.
Wheat	Dwarf bunt, flag smut (Pacific N.W.), stinking smut	[c]0.4 oz act. as a slurry or flowable formulation; 0.2 oz act. plus 1.0 oz actual maneb, slurry or dry/bu, or 1.0-2.0 oz act. plus equal amounts of captan and maneb for planter box.
	Stinking smut	0.2 to 0.42 oz act. as a slurry; 0.2 oz as a dust by machine or 0.53 as a dust by on-farm treatment; or 0.5 oz act. by automatic machine/bu.

---

[a] Do not use treated seed for food, feed, or oil.

[b] Dosage rates are given in terms of actual active ingredient.

[c] Hexachlorobenzene also is used in combination with captan or maneb on barley, bean, field corn, cotton, flax, oats, peanut, pea, rye, and soybeans, wherein the captan or maneb is the active agent.

Maneb Seed Treatments[a]

Crop	Diseases	Dosage rate for -	
		Machine application	Planter box application
		Oz act./100 lb	Oz act./100 lb
Barley	Covered and false loose smuts, damping-off, seed rots, seedling blights	0.75-2.0/bu	0.75-2.1/bu
		[b]0.75-1.0/bu	[c]0.75-1.8/bu
		---	[b]1.4 -2.1/bu
		---	[c]0.75-2.0/bu
		---	[d]0.8 -1.2/bu
		[e]0.73/bu	[e]0.73/bu
Bean	Damping-off, seed rots, seedling blights	1.0 -2.0/bu	1.0 -2.1/bu
		---	[f]0.75-1.8/bu
		---	[c]1.4 -2.1/bu
		---	[b]1.0 -2.0/bu
		---	[d]0.6 -1.2/bu
Corn	Damping-off, seed rots, seedling blights	1.0 -2.0/bu	0.87-2.1/bu
		[b]1.0/bu	[f]0.75-1.8/bu
		---	[c]1.4 -2.1/bu
		---	[b]1.0 -2.0/bu
		---	[d]0.6 -1.2/bu
		---	[g]1.4
Cotton	Damping-off, seed rots, seedling blights	---	0.60/bu
		---	[b]1.0 -2.0/100
		---	[d]0.6 -1.2/100
		---	0.8 -1.6/bu (acid delinted), or 4.8-8.0/bu (reginned or fuzzy[h])
Flax	Damping-off, seed rots, seedling blights	0.75-2.0/bu	1.5 -3.2/bu
		[b]2.0/bu	[b]1.5 -2.0/bu
		---	[d]0.6/bu
		[e]1.45/bu	[e]1.45/bu

See footnotes at end of table.

Maneb Seed Treatments[a]

Crop	Diseases	Dosage rate for -	
		Machine application	Planter box application
		Oz act./100 lb	Oz act./100 lb
Oat	Damping-off, seed rots, seedling blights, smuts	0.75-2.0/bu	0.75-2.1/bu
		[b]0.75-1.0/bu	[f]0.75-1.8/bu
		---	[c]1.4 -2.1/bu
		---	[b]0.75-2.0/bu
		---	[d]0.3 -1.2/bu
		[e]0.73/bu	[e]0.73/bu
Pea	Damping-off, seed rots, seedling blights	1.0 -2.0/bu	1.0 -2.1/bu
		---	[f]0.75-1.8/bu
		---	[c]1.4-2.1/bu
		---	[b]1.0 -2.0/bu
		---	[d]0.6 -1.2/bu
Peanut	Damping-off, seed rots, seedling blights	---	1.4 -2.1/100
		[i]0.75-2.25/100	[i]0.75-2.25/100
		[j]0.75-1.125	[c,k]1.4 -2.1/100
		---	[d]0.6 -1.2/100
		---	[j]0.75-1.125
Rye	Bunt, damping-off, seed rots, seedling blights	0.75-2.0/bu	0.75-2.1/bu
		[b]0.75-1.0/bu	[f]0.75-1.8/bu
		---	[c]1.4 -2.1/bu
		---	[b]0.75-2.0/bu
		---	[d]0.3 -1.2/bu
		[e]0.73/bu	[e]0.73/bu
Soybean	Damping-off, seed rots, seedling blights	0.75-2.0/bu	0.75-2.1/bu
		---	[f]0.75-1.8/bu
		---	[c]1.4 -2.1/bu
		---	[b]1.0 -2.0/bu
		---	[d]0.6 -1.2/bu

See footnotes at end of table.

Maneb Seed Treatments[a]

Crop	Diseases	Dosage rate for -	
		Machine application	Planter box application
		Oz act./100 lb	Oz act./100 lb
Sorghum	Covered kernel smut, damping-off, seed rots, seedling blights	[f]0.73/bu	[f]0.73/bu
Sugarbeet	Damping-off, seed rots, seedling blights	4.8 -8.0/100	---
Wheat	Bunt, damping-off, seed rots, seedling blights	0.75-2.0/bu	0.75-2.1/bu
		[b]0.75-1.0/bu	[f]0.75-1.8/bu
		[l]0.5/bu	[c]1.4 -2.1/bu
		---	[b]0.75-2.0/bu
		---	[d]0.15-1.2/bu
		[e]0.36/bu	[e]0.36/bu

[a] Maneb used as dust formulations only. Do not use treated seed for food, feed, or oil.
[b] In combination with 0.2-0.4 oz actual HCB/bu or 100 lb as indicated.
[c] In combination with 0.4-0.6 oz actual captan/bu or 100 lb as indicated.
[d] In combination with 0.2-1.2 oz actual captan and HCB/bu or 100 lb as indicated.
[e] In combination with HCB and captan. Maneb to HCB to captan ratio of 7:4:1.
[f] In combination with 0.75-1.8 oz actual captan/bu or 100 lb as indicated.
[g] In combination with 0.74 oz actual thiram.
[h] In combination with equal amounts of PCNB.
[i] In combination with equal amounts of captan.
[j] In combination with equal amounts of actual captan plus 0.4 to 0.6 oz actual PCNB and 0.1 to 0.15 oz actual etridiazole.
[k] In combination with 1.5-2.1 oz actual captan/100 lb.
[l] In combination with 0.1 oz of HCB/bu.

Thiram Seed Treatments[a]

Crop	Dosage rate for-	
	Slurry method of application	Dry method of application
	Oz act./ 100 lb	Oz act./ 100 lb
Barley[b]	2.04	2.04
Bean, lima	1.4 -1.8	1.5 -2.5
Bean, snap or dry	0.93-1.8	1.0 -1.66
Beet, table or sugar	3.73-4.0	4.0
Broccoli	3.73-4.0	4.0
Brussels sprouts	3.73-4.0	4.0
Cabbage	3.73-4.0	4.0
Cantaloup	2.1 -2.5	2.5
Carrot	3.73-4.0	4.0
Castor bean	2.1 -2.25	2.25
Cauliflower	3.73-4.0	4.0
Collards	3.73-4.0	4.0
Conifers	2.0 lb/100 (pelleted)	---
Corn, field	1.25-1.65 [c]1.12	1.5 [d]0.74
Corn, sweet[b]	2.5 - 4.0 [c]2.1 -3.76	1.5 [d]0.74
Cotton, acid delinted[b]	1.89 [e]2.25	2.25-3.0 ---
Cotton, fuzzy	1.89-2.10 [e]2.25	2.25 ---
Cotton, reginned[b]	1.89-2.10 [e]2.25	2.25 ---
Cucumber	2.1 -2.25	2.25
Eggplant	2.8 -3.0	4.0
Endive	3.73-4.0	4.0
Flax	2.68	2.68

See footnotes at end of table.

Thiram Seed Treatments[a] -- con.

Crop	Dosage rate for-	
	Slurry method of application	Dry method of application
	Oz act./ 100 lb	Oz act./ 100 lb
Grasses	3.73-4.0	4.0
Kale	3.73-4.0	4.0
Kohlrabi	3.73-4.0	4.0
Legumes, small-seeded	3.73-4.0	4.0
Lettuce	3.73-4.0	4.0
Millet	1.86-2.0	3.0
Mustard	3.73-4.0	4.0
Okra	2.8 -3.0	3.0
Onion	3.0	3.0 or 8.0 oz/1.0 lb (pelleted)
Onion, bulb	---	8.0 oz/10 lb
Onion, set	---	8.0 oz/10 lb
Pea, blackeye	0.93-1.0	1.0 -1.66
Pea, garden and field	1.4 - 1.8	1.5 -1.66
Peanut, shelled	2.1 -2.4	2.25-3.75
Peanut, unshelled	---	1.6
Pepper	3.73-4.0	4.0
Pumpkin	2.1 -2.25	2.25
Radish	3.73-4.0	4.0
Rice	1.55-3.3	2.15
Rye	1.84	1.84
Safflower	2.0	2.0
Sesame	1.4 -1.5	1.5
Sorghum	1.66-1.79	1.34
Soybeans	0.93-1.8	1.0 -1.66
Spinach	3.73-4.0	4.0
Squash	2.1 -2.25	2.25

Thiram Seed Treatments[a] -- con.

Crop	Dosage rate for-	
	Slurry method of application	Dry method of application
	Oz act./ 100 lb	Oz act./ 100 lb
Swiss chard	3.73-4.0	4.0
Tomato	2.8 -3.0	4.0
Turnip	3.73	4.0
Watermelon	2.1 -2.25	2.25
Wheat[b]	1.66 [f]1.12-1.5	1.66 [f]1.12-1.5

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[a] Do not use treated seed for food, feed, or oil.

[b] Also used in combination with carboxin.

[c] In combination with equal amounts of captan.

[d] In combination with 1.4 oz actual maneb. Planter box treatment only.

[e] In combination with 4.0 oz actual chloroneb.

[f] In combination with 1.12-1.5 oz actual carboxin.

Zineb Seed Treatments[a]

Crop	Dosage rate for-	
	Slurry method of application	Dry method of application
	Oz act.	Oz act.
Alfalfa	4.00/100 lb	5.67/100 lb
Barley	0.47/bu	0.53/bu
Bean	0.74/bu	1.05/bu
Beet, sugar	2.94/100 lb	1.26/100 lb
Beet, table	5.67/100 lb	8.40/100 lb
Bluegrass	4.00/100 lb	5.67/100 lblb
Cantaloup	1.47/100 lb	2.10/100
Clover	4.00/100 lb	5.67/100 lb
Corn	0.47/bu	0.53/bu
Cotton, acid delinted	0.84/100 lb	1.05/100 lb
Cotton, fuzzy	1.26/100 lb	1.47/100 lb
Cotton, reginned ...	2.10/100 lb	2.94/100 lb
Crucifers	0.74/100 lb	1.05/100 lb
Cucumber	1.47/100 lb	2.10/100 lb
Flax	0.95/bu	1.26/bu
Oats	0.47/bu	0.53/bu
Pea, blackeye	0.74/bu	1.05/bu
Pea, garden and field	0.74/bu	1.26/bu
Pepper	1.47/100 lb	2.10/100 lb
Pumpkin	0.95/100 lb	1.47/100 lb
Sorghum, hulled	0.74/bu	0.79/bu
Soybeans	0.74/bu	1.05/bu
Spinach	2.94/100 lb	4.20/100 lb
Squash	0.95/100 lb	1.47/100 lb
Swiss chard	5.67/100 lb	8.40/100 lb
Watermelon	0.95/100 lb	1.47/100 lb
Wheat	0.47/bu	0.52/bu

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[a] Zineb not used alone; formulated as a 21% wettable powder in combination with 22% captan. Do not use treated seed for food, feed, or oil.

FIELD CROP DISEASES

by

Herman L. Warren

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ALTERNATIVE CONTROL MEASURES

Cultural Practices

Cultural practices and preventive measures are an integral part of pest-control strategies and can help reduce the amount of damage caused by plant pathogens of field crops. The use of such cultural practices as crop rotation, sanitation, timing of planting, mineral nutrition, and reduced or minimal tillage can lower the severity of some diseases. These practices are only partially effective, however, where field crops are grown intensively. Some cultural control measures are incompatible with current management practices (for example, reduced tillage systems and high plant populations) aimed toward conservation of energy, high yield, and protection of soil loss from erosion. Therefore, control measures are most effective in combination with other management practices. Cultural practices are designed to disrupt the favorable combination of biotic and environmental factors necessary for pathogen development. Many fungi, bacteria, and viruses of field crops cannot be controlled effectively if they become established during the cropping season. Therefore, pest-control strategies must be emphasized that include cultural practices in combination with fungicides, insecticides, and herbicides, where vectors are involved.

Seeding date: Seeding date must be balanced against available moisture and the overall pest problem. Delayed planting for spring-planted field crops or planting before frost-free date for fall-planted crops disrupts the timing between a susceptible stage of the host and the infection cycle of the pathogen. Seeding in cold, wet soils generally increases seedling diseases, but it reduces stress and avoids severe losses from pests that develop late in the season. Early planted and short-season varieties may escape diseases and other pests before such pests become well established.

Tillage: Tillage is an indirect control measure for diseases and a direct control for weeds that harbor plant pathogens. Even where herbicides are used, tillage is a valuable component of the disease-control program. Clean cultivation removes some alternate hosts of the pathogen, and deep plowing buries infested crop residues, which hasten decomposition. In some areas, clean cultivation is incompatible with current management practices that protect losses from soil erosion, and monocropping tends to be favored. Crop residues on the soil surface enhance some diseases by maintaining high populations of organisms where they are disseminated easily when a disease becomes severe under reduced tillage systems. The use of pesticides and deep fall plowing or other cultural controls is recommended to interrupt the life cycle of the pathogen. Minimum tillage will control some diseases; however, it tends to increase others because of lowered soil temperature and preservation of moisture. Thus, severity of diseases previously controlled by other cultural practices, such as crop rotation, may increase or decrease in a minimum tillage system.

Crop rotation: Crop rotation is one of the most economically effective nonchemical means of decreasing severity of most soilborne diseases. Most long-term crop rotation studies involving field crops show that crop rotation reduces disease severity. The importance of using crop rotation for disease control depends upon the seriousness of a specific disease, inasmuch as other diseases may be enhanced by crop rotation. In a rotation system, crop sequence is more important than length of the rotation period between crops in determining the complexity of the disease problem. Some crops seldom are used in rotation schemes because of common susceptibility to the fungus Gibberella zeae, which has a wide host range. Frequent rotations of crops with common pathogens may result in the buildup of other pathogens on crops in the rotation scheme.

Sanitation: Sanitation and disease-free seed economically control some diseases of field crops, especially smut of small grains. Systemic and seedborne diseases must be controlled with fungicides or by sanitation before or during the preplant period. Hot-water treatment may be used when seeds are infected lightly. Destruction of crop residue by deep plowing helps control disease; however, minimum tillage practices are being used more frequently.

Host-Plant Resistance

Control of field crop diseases is an important phase of crop production. The most efficient way to control most field crop diseases is to use adapted disease-resistant cultivars. Resistance is not always effective or lasting, however, because of the constantly changing genotypes of the host and the pathogen. For some crops, resistant cultivars are unavailable; therefore, tolerant cultivars may be used. One or more cultural practices, and a tolerant cultivar, may be used to reduce diseases to a manageable level. Breeding plants for resistance is a continuing process, owing to the development of new pest biotypes and changes in the behavior of the pest and the host. One should avoid planting susceptible varieties in areas where diseases are known to occur.

Biological Control

Currently, no strategies used commercially involve the direct application of biological agents for the control of pathogens of field crops. Several naturally occurring parasites help regulate populations of plant pathogens. For example, manipulation of cultural practices to enhance indigenous populations of antagonistic organisms of soilborne pathogens is important in regulating some diseases.

Specific Alternative Control Measures

BARLEY

Covered smut (*Ustilago hordei*): Resistant varieties, hot-water seed treatment, sanitation by selection of nearly smut-free seed.

Black loose smut (*Ustilago nigra*): Resistant varieties, hot-water treatment, selection of clean seed.

Loose smut (*Ustilago nuda*): Hot-water treatment, sanitation by selection of clean seed.

Helminthosporium leaf blights (*H. teres*, net blotch; *H. sorokinianum*, spot blotch): Resistant varieties, rotation with legumes, date of seeding in some areas, balanced fertility.

Rust (*Puccinia* spp.): Resistant varieties.

Seed rots, damping-off, and seedling blights: Tolerant varieties, crop rotation, later seeding date, balanced fertility.

CORN (field)

Anthracnose (*Colletotrichum graminicola*): Resistant hybrids, crop rotation, deep plowing to incorporate infested residues into soil, clean seed.

Helminthosporium leaf blights (*H. maydis*, southern corn leaf blight; *H. turcicum*, northern corn leaf blight; *H. carbonum*, northern leaf spot): Resistant hybrids.

Seed rots and seedling blights, various causes: Resistant hybrids, delayed planting until soil temperature is above 62°F, clean seed.

COTTON

Seedborne seedling diseases (*Glomerella gossypii*, *Xanthomonas malvacearum*, and species of *Fusarium*, *Alternaria*, *Aspergillus*, *Diplodia*, and *Thielaviopsis*): Resistant varieties, delayed date of seeding, crop rotation.

Soilborne seedling diseases (*Rhizoctonia solani* and species of *Pythium*, *Fusarium*, *Thielaviopsis*, *Alternaria*, and *Aspergillus*): Tolerant and resistant varieties, crop rotation, balanced fertility.

Southwestern cotton rust (*Puccinia cacabata*): Resistant varieties.

OATS

Covered smut (*Ustilago kolleri*) and Loose smut (*U. avenae*): Resistant varieties; hot-water treatment; sanitation; disease-free, high-quality seed.

Seedling blights and seed rots: Delayed seeding date, clean seed, balanced fertility.

Crown rust (*Puccinia coronata*): Resistant varieties.

RICE

Seedling blights and seed rots: Resistant varieties, clean seed, crop rotation, balanced fertility

RYE

Covered smut (bunt)(*Tilletia caries*): Resistant varieties; sanitation; disease-free, good-quality seed.

Seedling blights and seed rots: Tolerant varieties, delayed seeding date, tillage system, crop rotation, balanced fertility.

Leaf blights (*Helminthosporium* spp.) and Leaf spot (*Septoria* spp.): Resistant varieties, crop rotation.

SORGHUM (field and sweet)

Loose kernel smut(*Sphacelotheca cruenta*) and Covered smut (*S. sorghi*): Resistant varieties, sanitation.

Head smut (*Sphacelotheca reiliana*): Crop rotation, resistant varieties, sanitation.

Seedling blights and seed rots: Delayed seeding date, crop rotation.

SUGARBEET

Leaf spot (*Cercospora beticola*): Resistant varieties, crop rotation, weed control.

Seed decay and damping-off: Delayed seeding date, crop rotation, balanced fertility.

SUGARCANE

Pineapple disease (*Ceratocystis paradoxa*): Crop rotation, tolerant varieties.

Pythium root rot (*Pythium* spp.): Crop rotation, seeding date.

TOBACCO

Blue mold (*Peronospora tabacina*), Anthracnose (*Colletotrichum destructivum*), and damping-off: Crop rotation, tolerant varieties.

Brown spot (*Alternaria alternata*): Tolerant varieties, sucker control, early harvest.

Wildfire (*Pseudomonas tabaci*): Resistant varieties, crop rotation, selection of clean plants, early harvest.

WHEAT

Covered or stinking smut (bunt) (*Tilletia caries* and *T. foetida*): Resistant varieties, hot-water seed treatment, seeding date, disease-free seed.

Flag smut (*Urocystis tritici* or *U. agropyri*): Disease-free seed, sanitation.

Loose smut (*Ustilago tritici*): Disease-free seed, sanitation, tolerant varieties.

Stem and leaf rusts (*Puccinia graminis tritici* and *P. recondita*): Resistant varieties, delayed seeding date, short-season varieties.

Leaf blights, blotch, and spot (*Helminthosporium* and *Septoria* spp.): Resistant varieties, crop rotation, date of seeding, weed control.

Seedling blights and seed rots: Date of seeding, crop rotation, sanitation, weed control, balanced fertility.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
BARLEY					
Covered smut (*Ustilago hordei*)	TCMTB	—*	L, EC 0.5 oz/100 lb	Apply as liquid or sprinkle and mix seed.	For all chemicals on this page: Seed treatment only. Do not use treated seed for food, feed, or oil purposes.
	Captan + Thiram (1:1)	—*	SL or D 4.5 oz/100 lb	Apply dry or as a slurry and mix thoroughly with seed.	
	Formaldehyde	—*	L 0.37 lb/40 gal water	Seed dip or sprinkle and mix seed.	
	Maneb	—*	D 1.8-3.3 oz/100 lb SL 1.6-4.2 oz/100 lb	Apply dry or as a slurry and mix thoroughly with seed.	
	Paraformaldehyde	—*	D 0.37 oz/100 lb	Mix with seed and wait 15 hr before planting.	
	PCNB	—*	L or SL 1.0-2.2 oz/100 lb	Apply as a liquid or slurry and mix thoroughly with seed.	
	PCNB-Etridiazole (4:1)	—*	L 1.2-2.6 oz/100 lb	Apply undiluted as liquid and mix thoroughly with seed.	
	Thiram	—*	D or SL 2 oz/100 lb	Apply dry or as a slurry and mix thoroughly with seed.	
Black loose smut (*Ustilago nigra*)	Formaldehyde	—*	L 0.37 lb/40 gal water	Seed dip or sprinkle and mix seed.	
	Maneb	—*	D 1.8-3.3 oz/100 lb SL 1.6-4.2 oz/100 lb	Apply dry or as a slurry and mix thoroughly with seed in planter box.	
Loose smut (*Ustilago nuda*)	Carboxin	—*	D, L, or SL 1.5-2.2 oz/100 lb		Do not use treated crop, including hay, straw, and grain, as food or feed. Do not graze treated crop.
Helminthosporium leaf blights (*H. teres* net blotch; *H. sorokinianum*, spot blotch)	Mancozeb	26	WP or D 1.6 lb/acre in water	Apply to foliage beginning at tillering; repeat at 7-10-day intervals.	Do not graze or harvest for 26 days after last application.
Powdery mildew (*Erysiphe graminis hordei*)	Triadimefon	21	WP 1-2 oz/at least 5 gal water by aircraft or 10 gal water by ground/acre.	Apply at the first signs of disease and when new powdery mildew symptoms reappear; 1 or 2 applications.	Total amount of triadimefon should not exceed 8 oz per acre per crop season.
Rust (stripe, leaf, and stem) (*Puccinia* spp.)	Sulfur	NTL**	WP or D 25 to 40 lb/acre	Spray all plant parts; repeat at 7-10-day intervals.	Limit: 50 lb/acre.
	Triadimefon	21	WP 3-4 oz/at least 5 gal water by aircraft or 10 gal water by ground/acre.	Use in areas of severe infection; 1 or 2 applications.	Total amount of triadimefon should not exceed 8 oz per acre per crop season.

* Does not apply.
** No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
BARLEY					
Seed rots, damping-off, and seedling blights	Captan	--*	WP, D, or SL SL 0.6-2.0 oz/100 lb	Apply dry or as a slurry and mix thoroughly with seed.	For the 6 seed-treatment chemicals for seed rots, damping-off, and seedling blights: Do not use treated seed for food or feed.
	Carboxin	--*	WP, L, or SL 1.5-2.2 oz/100 lb		
	Maneb	--*	D 1.8-3.3 oz/100 lb SL 1.6-4.2 oz/100 lb		
	Thiram	--*	D or SL 2 oz/100 lb		
	Zineb-Captan	--*	D 2.2 oz/100 lb SL 2.0 oz/100 lb		
	Metalaxyl (*Pythium* spp. only)	--*	WP 0.2-0.5 oz/100 lb	Apply as a slurry and mix thoroughly with seed.	Seed treatment only. Do not use treated seed for food or feed.
CORN (FIELD)					
Helminthosporium leaf blights (*H. maydis*, *H. turcicum*, and *H. carbonum*) and rust	Copper salts of fatty and rosin acids	NTL**	0.5 gal of 4% metallic copper equivalent/acre	Foliar spray repeated in 5-10 days.	For *H. maydis* only. Use limited to North Central States.
	Chlorothalonil	14	FL (4.17 lb a.i./gal), 0.6-1.4 lb/acre	Begin foliar application when conditions favor disease development and repeat at 4-7-day intervals.	Apply only to corn grown for seed. Do not apply within 14 days of harvest. Do not allow livestock to graze in treated corn or use as livestock forage.
	Mancozeb	40	WP or D 1.2 lb/acre in sufficient water to cover thoroughly.	Begin when disease first appears; repeat at 4-7-day intervals.	Do not apply within 40 days of harvest.
	Zineb	40	WP or L 3 lb/acre	Foliar spray repeated in 5-10 days.	Do not feed treated forage to dairy animals or animals being finished for slaughter. Do not apply within 40 days of harvest.

* Does not apply.
** No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CORN (FIELD) Seed rots, damping-off, and seedling blights, various causes	TCMTB	--*	L or EC 0.67 oz/100 lb	Apply as a liquid and mix thoroughly with seed.	For all seed rots, damping-off, and seedling blights chemicals: Seed treatment only. Do not use treated seed for food, feed, or oil purposes. Captan may be used with various other pesticides.
	Captan	--*	SL or D 0.5-1.2 oz/100/lb SL; 0.8-1.8 oz/100 lb D	Apply dry or as a slurry and mix thoroughly with seed.	
	Thiram	--*	WP or D 1.33-1.65 oz/100 lb SL; 1.5 oz/100 lb D	Same as above.	Thiram may be used with various other fungicides.
	Fenaminosulf (Pythium spp. only)	--*	WP 0.3-0.5 oz/100 lb	Apply as a slurry and mix thoroughly with seed.	
	PCNB	--*	SL 0.9 oz/100 lb	Same as above.	PCNB can be used with various other fungicides.
	Metalaxyl (Pythium spp. only)	--*	WP 0.2-0.5 oz/100 lb	Same as above.	
COTTON Seed rot and damping-off (Pythium spp.)	Metalaxyl	--*	WP 0.2-0.5 oz/100 lb	Apply as a slurry and mix thoroughly with seed.	For the remaining chemicals on this page: Seed treatment only. Do not use treated seed for food, feed, or oil purposes.
Seed rot and damping-off (Pythium spp.) and Anthracnose	Fenaminosulf	--*	WP 1.4-2.1 oz/100 lb	Same as above.	Fenaminosulf is used with other seed-protectant fungicides or chlorothalonil.
Seedborne seedling diseases (Glomerella gossypii, Xanthomonas malvacearum, and species of Fusarium, Alternaria, Aspergillus, Diplodia, and Thielaviopsis)	Captan	--*	Various 0.75-4 oz/100 lb	Dosage depends upon whether fuzzy, reginned, or acid-delinted seed is used. See manufacturer's label.	
	Carboxin	--*	WP or F 6.0 oz/100 lb	Single dosage for all types of delinting. See manufacturer's label.	Carboxin may be used with other seed-protectant fungicides. Do not graze or feed livestock on hay grown from treated seed.
	Chloroneb	--*	WP 6.5 oz/100 lb	Use only as a supplemental seed treatment to suitable standard seed protectants.	

* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
COTTON Seedborne seedling diseases (*Glomerella gossypii*, *Xanthomonas malvacearum*, and species of *Fusarium*, *Alternaria*, *Aspergillus*, *Diplodia*, and *Thielaviopsis*) (con.)	Etridiazole	--*	Various EC formulations 1.0-2.5 oz/100 lb	Dosage depends upon whether fuzzy, reginned, or acid-delinted seed is used. See manufacturer's label.	For the first 5 chemicals on this page: Seed treatment only. Do not use treated seed for food, feed, or oil purposes. Etridiazole is used with other seed-protectant fungicides.
	PCNB	--*	Various EC and WP formulations 3-4 oz/100 lb	Dosage depends upon whether fuzzy, reginned, or acid-delinted seed is used. See manufacturer's label.	PCNB is often used with other seed-protectant fungicides.
	TCMTB	--*	EC or Flowable 1.3-1.9 oz/100 lb	Same as above.	
	Thiram	--*	Various WP formulations 1.89-3.0 oz/100 lb		
Soilborne seedling diseases (*Rhizoctonia solani* and species of *Pythium*, *Fusarium*, *Thielaviopsis*, *Alternaria*, and *Aspergillus*)	TCMTB	--*	Flowable or EC 1.3-1.9 oz/100 lb	Same as above.	
	Captan + PCNB	--*	1 lb captan and 1 lb PCNB/14,500 linear ft of row	Apply in-furrow at planting time to soil that surrounds and covers seed.	Do not allow food animals to eat foliage or vines in or from treated fields Do not feed gin waste to livestock. Do not plant any root crop not registered for PCNB in rotation on PCNB-treated soil. Use with cottonseed pretreated with a suitable seed-protectant fungicide.
	Carboxin	--*	WP or Flowable 6.0 oz/100 lb	Single dosage for all types of delinting. See manufacturer's label.	Seed treatment only. Do not use treated seed for food, feed or oil purposes. Carboxin may be used with other seed-protectant fungicides. Do not graze or feed livestock on hay grown from treated seed.

* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
COTTON Soilborne seedling diseases (Rhizoctonia solani and species of Pythium, Fusarium, Thielaviopsis, Alternaria, and Aspergillus) (con.)	Chloroneb	—*	WP, D, or G 1-2 lb as 10% D or G, or 1.3-1.95 lb as WP in 10-20 gal water/acre (12,000 to 12,400 linear ft of row)	Apply in-furrow at planting time to soil that surrounds and covers seed.	Use only on cottonseed pretreated with a suitable standard seed-protectant fungicide.
	NIA 5961	—*	Various EC and G formulations 1.0-2.0 lb as EC or G per 12,400 to 13,000 linear ft of row	Apply in-furrow at time of planting at bottom of furrow. Immediate sealing with a packing wheel is desirable.	Do not allow food animals to eat foliage or vines in or from treated fields. May be used with PCNB. Used with cottonseed pretreated with a suitable seed-protectant fungicide.
	PCNB-Etridiazole (4:1)	—*	Various EC, D, and G formulations 0.25-0.37 lb etridiazole and 1.0-1.5 lb PCNB; or 0.25 lb and 1.5 lb as D or G/12,400 linear ft of row	Apply in-furrow at time of planting to soil that surrounds and covers seed.	Do not graze dairy or meat animals in treated fields. Do not feed gin waste to livestock. Do not plant any root crop not registered for PCNB in rotation on PCNB-treated soil. Use with cottonseed pretreated with a suitable seed-protectant fungicide.
	Mancozeb	—*	D or SL 3.0-6.0 oz/100 lb	Dosage depends on whether fuzzy, reginned, or acid-delinted seed is used. See manufacturer's label.	Seed treatment only. Do not use treated seed for food, feed, or oil purposes.
Southwestern cotton rust (Puccinia cacabata)	Mancozeb	Do not apply after bolls open.	WP 1.0-1.6 lb/acre in sufficient water for thorough coverage.	Begin when rust first appears in area; repeat at 10-14-day intervals.	Southwestern States only. Do not apply after bolls open. Do not graze treated areas. Do not feed gin trash to livestock.
OATS Covered smut (Ustilago kolleri) and Loose smut (U. avenae)	PCNB	—*	SL 1.0-3.2 oz/100 lb	Apply dry or as a slurry and mix thoroughly with seed.	Seed treatment only. Do not use treated seed for food or feed.

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* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
OATS Seedling blights and seed rots	Captan	—*	SL 0.6-2.8 oz/100 lb D 0.6-3.0 oz/100 lb	Apply dry or as slurry and mix thoroughly with seed.	For all oats seedling blights and seed rots chemicals: Seed treatment only. Do not use treated seed for food or feed.
	Carboxin	—*	Planter box, D, L, or SL 0.7-1.1 oz/100 lb	Same as above.	
	Mancozeb	—*	SL or D 2.5-5.9 oz/100 lb	Apply dry or as a slurry and mix thoroughly with seed; in seed treater or planter box.	
	Maneb	—*	D 2.7-6.5 oz/100 lb	Apply dry and mix thoroughly with seed.	
	Zineb-Captan (1:1)	—*	SL 3.0 oz/100 lb D 3.4 oz/100 lb	Apply dry or as a slurry and mix thoroughly with seed.	
	Metalaxyl (*Pythium* spp. damping-off only)	—*	WP 0.2-0.5 oz/100 lb	Apply as a slurry and mix thoroughly with seed.	
RICE Seedling blights and seed rots	Benomyl	—*	WP 0.5-1 lb/acre	Apply at booting and repeat at heading stage.	Do not use in California. Do not apply on stubble rice. Do not apply to field where crayfish or catfish farming is practiced, nor drain water into areas where such farming is practiced.
	Captan	—*	D or SL 0.9-3.75 oz/100 lb SL; 0.8-3.75 oz/100 lb dry	Apply before, during, or after soaking seed in water.	Seed treatment only. Do not use treated seed for food or feed.
	Dichlone	—*	F 1 oz/100 lb	Same as above.	
	PCNB-Etridiazole (4:1)	—*	L 1.3-2.7 oz/100 lb	Apply undiluted as liquid or mix with water to assure coverage.	
	Thiram	—*	D or SL 1.55-3.3 oz/100 lb SL; 2.15 oz/100 lb dry	Apply before, during, or after soaking seed in water.	Thiram may be used with other seed-protectant fungicides.
	Mancozeb	—*	D or SL 1.6-3.2 oz/100 lb	Same as above.	
	Metalaxyl (*Pythium* spp. Damping-off only)	—*	WP 0.2-0.5 oz/100 lb	Apply as a slurry and mix thoroughly with seed.	Seed treatment only. Do not use treated seed for food or feed.

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* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
RYE					
Covered smut (bunt) (Tilletia caries)	Maneb	--*	D 1.6-2.8 oz/100 lb SL 1.3-3.6 oz/100 lb	In seed treater. In planter box.	For all rye covered smut, stem smut, and seedling blights and seed rots chemicals: Seed treatment only. Do not use treated seed for food or feed.
Stem smut (Ustilago spegazzini)	Formaldehyde	--*	L 0.37 lb/40 gal water	Dip seed or sprinkle while mixing.	
Seedling blights and seed rots	Captan	--*	WP, D, or SL 0.6-1.6 oz/100 lb SL 0.6-1.5 oz/100 lb D	Apply dry or as a slurry and mix thoroughly with seed. May be applied in planter box.	
	Maneb	--*	D 1.6-3.7 oz/100 lb SL 1.3-3.6 oz/100 lb	In seed treater. In planter box.	
	Metalaxyl (Pythium spp. damping-off only)	--*	WP 0.2-0.5 oz/100 lb	Apply as a slurry and mix thoroughly with seed.	
	Thiram	--*	L, WP, D, or SL 1.84 oz/100 lb	Apply dry or as a slurry and mix thoroughly with seed.	
	Mancozeb	--*	WP or D 1.7-2.9 oz/100 lb	Same as above.	
Leaf blights (Helminthosporium spp.) and Leaf spot (Septoria spp.)	Mancozeb	26	WP, D, or Flowable 1.6 lb/acre in water	Apply to foliage beginning at tillering; repeat at 7-10-day intervals. Do not make more than 3 applications per season.	Do not graze or harvest for 26 days after last application.
SORGHUM (FIELD AND SWEET)					For the remainder of all chemicals on this page: Seed treatment only. Do not use treated seed for food or food. Captan can be used with other seed-protectant fungicides.
Loose kernel smut (Sphacelotheca cruenta), Covered smut (S. sorghi), Seedling blights, seed rots, and head smut (S. reiliana)	Captan	--*	D or SL 1.9-2.3 oz/100 lb SL 2-3 oz/100 lb dry	Apply dry or as a slurry and mix thoroughly with seed.	
	Copper carbonate	--*	D 1.2-1.6 oz metallic copper/100 lb	Apply as a dust and mix thoroughly with seed.	
	Fenaminosulf	--*	WP 0.7-1.4 oz/100 lb	Apply dry or as a slurry and mix thoroughly with seed.	
	Dichlone	--*	F 1 oz/100 lb	Same as above.	
	Maneb	--*	D or SL 0.6-1.4 oz/100 lb	Same as above.	Maneb is used with other seed-protectant fungicides, such as captan.
	PCNB-Etridiazole (4:1)	--*	L 0.6 oz/100 lb	Apply as liquid to seed and mix thoroughly to assure coverage.	

* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
SORGHUM (FIELD AND SWEET)					
Seed rot and damping-off (Pythium spp.) and Covered kernel smut	Fenaminosulf	—*	WP 0.7-1.4 oz/100 lb	Apply specific dosage to 100 lb of seed in a slurry.	Seed treatment only. Do not use treated seed for food or feed. Use higher rate only if adequate soil moisture is present to avoid possible injury to seedlings.
SUGARBEET					
Leaf spot (Cercospora beticola)	Benomyl	21	WP 0.188-0.250 lb in sufficient water/acre	Foliage application. Begin when disease appears; repeat at 14-21-day intervals. Ground application only.	Do not graze or feed treated tops to livestock.
	Copper-ammonium complex	NTL**	L 0.26-0.58 lb/acre	Foliage application. Begin when disease appears; repeat at 14-21-day intervals.	Harmful if swallowed.
	Fixed copper	NTL**	WP 3-4 lb/25-100 gal water; D 3-4 lb/acre	Foliage application. Begin when disease appears; repeat at 7-10-day intervals.	Harmful if swallowed.
	Copper hydroxide	NTL**	WP 0.56-2.8 lb/acre. Add 2 qt of suitable spray oil/acre as a spreader-sticker.	Foliage application. Begin when disease threatens; repeat at 10-14-day intervals for 4-5 applications as needed.	Harmful if swallowed.
	Maneb	14	WP, D, or F 1.2-2.4 lb in sufficient water/acre. Add spreader-sticker.	Foliage application. Begin when disease threatens; repeat at 7-10-day intervals for 3-5 applications.	Do not feed treated tops to livestock if more than 1.6 lb active ingredient has been applied per acre.
	NIA 9102	—*	1.2-2.4 lb/100-150 gal water/acre	Begin when disease first appears; repeat at 7-10-day intervals.	Do not feed treated tops to meat or dairy animals.
	Thiabendazole	21	WP or F 3-6 oz/acre	Foliage application. Begin when disease appears; repeat at 14-21-day intervals. By ground equipment 25-125 gal water/acre; by air, 3-10 gal water/acre.	Do not graze or feed treated tops to livestock. Do not use treated tops for silage. Do not make more than 5 applications per season.
	Fentin hydroxide	14	WP 1.9-4.75 oz/acre	Foliage application. Begin when disease appears; repeat at 10-14-day intervals. In ground application use at least 15 gal water/acre; by air, at least 5 gal water/acre.	Do not graze or feed treated tops to livestock.

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* Does not apply.
** No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
SUGARBEET					
Seed decay and damping-off (*Aphanomyces* and *Pythium* spp.)	Chloroneb	—*	D or SL 3.9 oz/100 lb	Mix thoroughly with seed.	For all seed decay and damping-off chemicals: Seed treatment only. Do not use treated seed for food or feed.
	Fenaminosulf	—*	WP 1.4-2.8 oz/100 lb. Seeds planted in soil high in clay or organic composition may require 4.2 oz/100 lb.	Apply as a slurry and mix thoroughly with seed. In light soils, do not exceed 2.8 oz/100 lb.	
	Etridiazole	—*	L 0.375-0.750 oz/100 lb	Mix thoroughly with seed.	Etridiazole is used with PCNB.
	PCNB-Etridiazole (4:1)	—*	SL or L 1.9-3.7 oz/100 lb	Apply as a slurry or liquid. Mix thoroughly with seed.	
SUGARCANE					
Pineapple disease (*Ceratocystis paradoxa*)	Benomyl	—*	WP 1/8 lb per 100 gal water; or 1/4 lb per 100 gal water	Apply as 20-30 minute dip at 50°C. Apply as dip to cuttings, thoroughly wetting at ambient temperature.	Seed piece treatment only. Do not use treated seed pieces for food or feed.
Pythium root rot (*Pythium* spp.)	Fenaminosulf	—*	7 oz/133 gal water per 1,250 sq ft of seedbed	Apply at weekly intervals for 8-12 weeks.	In propagation seedbeds only.
SWEET SORGHUM	(See Sorghum)				

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* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
TOBACCO Blue mold (Peronospora tabacina), Anthracnose (Colletotrichum destructivum), and Damping-off	Streptomycin sulfate	--*	L 100 p/m (200 p/m when blue mold is established).	Spray when plants in plant bed are in 2-leaf stage. Spray each week for 5 weeks.	Seedbed treatment only.
	Ferbam	--*	WP 2.3-3.0 lb/100 gal	Use 3 gal of suspension/100 sq yd of bed when plants are small, increasing to 6 gal as plants become larger; or use 0.1-0.4 lb as a D/100 sq yd. Begin dusting or spraying when leaves are the size of a dime or when disease is first reported in the area.	
	Maneb	--*	WP, D, or F 0.4-3.2 lb/100 gal; 0.04-0.13 lb/100 sq yd of plant bed.	Use 2.5-5 gal of diluted suspension of WP (0.5 g/100 sq yd) or the dust/100 sq yd of bed. Begin when plants are the size of a dime or when blue mold is first reported in the area; repeat twice weekly until plants are set in field. Use lower rates in early applications, increasing to higher rates as plants increase in size.	Injury to plant may result at higher than recommended rates.
	Metalaxyl	--*	Formulated as a 25.11% a.i. EC (2 lb a.i./gal). Flue-cured tobacco: 1-2 qt of formulation per acre.	Before transplanting, broadcast and incorporate in the top 2-4 inches of soil. Under low disease pressure or for early season control use 1 qt/acre; under high disease pressure or for full season control, use 2 qt/acre.	For blue mold only. If replanting is necessary, tobacco may be replanted immediately. Do not make a second application.
			Burley and other than flue-cured tobacco: 2 qt of formulation per acre.	Broadcast and incorporate in the top 2-4 inches of soil.	
	NIA 9102	--*	WP or D 1.2-1.6 lb/100 gal. Apply 3-6 gal/100 sq yd of plant bed or 0.07-0.14 lb as a D/100 sq yd.	Begin when plants are the size of a dime. One treatment is usually sufficient, but sprays can be repeated 2 or 3 times each week until transplanting without injuring plants.	

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* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
TOBACCO					
Blue mold (*Peronspora tabacina*), Anthracnose (*Colletotrichum destructivum*), and Damping-off (con.)	Zineb	—*	WP 1.125-2.25 lb/100 gal D 0.03-0.75 lb/100 sq yd.	Plant bed. Use 3-6 gal of suspension/100 sq yd of bed. Begin with lower rates when plants are the size of a dime, or when disease is first reported in the area; repeat at 3-4-day intervals until transplanting, increasing the rates as the plants increase in size.	
			D 2-8 lb/acre	Field. Begin soon after transplanting. Apply as necessary, usually about 1-3 times/year.	
Wildfire (*Pseudomonas tabaci*)	Streptomycin sulfate	—*	L 100 p/m (200 p/m when wildfire is established)	Spray when plants in plant bed are in 2-leaf stage. Spray each week for 5 weeks.	
Brown spot (*Alternaria alternata*)	Anilazine	—*	WP 1 lb/100 gal/acre	Apply at weekly intervals during harvest, after each priming.	Limit: 1 lb/acre.
WHEAT					
Covered or Stinking smut (bunt) (*Tilletia caries* and *T. foetida*)	Carboxin	—*	D, L, or SL 1.5-2.2 oz/100 lb		For the remainder of the chemicals on this page: Seed treatment only. Do not use treated seed for food or feed.
	Copper carbonate	—*	D 0.8-1.6 oz metallic copper/100 lb	Apply as a dry mix.	
	Fixed copper	--*	D 1.7-3.3 oz metallic copper/100 lb		
	Formaldehyde	--*	L 0.37 lb/40 gal water	Seed dip or sprinkle and mix seed.	
	Hexachlorobenzene	--*	WP, D, or SL 1.2-1.6 oz/100 lb as SL on seed, 0.33 lb as D by machine, or 0.88 lb as D with farm treater.	Apply dry or as a slurry.	
	Maneb	--*	SL 1.2-3.3 oz/100 lb D 1.5-2.7 oz/100 lb	In seed treater. In planter box.	

* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
WHEAT					
Covered or Stinking smut (bunt) (*Tilletia caries* and *T. foetida*) (con.)	PCNB	—*	L or WP 0.8-1.2 oz/100 lb	Apply as a liquid and mix thoroughly with seed.	For the remainder of the chemicals on this page: Seed treatment only. Do not use treated seed for food or feed.
	PCNB-Etridiazole (4:1)	—*	L 1.0 oz/100 lb	Same as above.	
	Thiabendazole	—*	FL, 1.1-2.2 oz/100 lb	Apply as a liquid or slurry. Keep dispersion under constant agitation.	
	Thiram	—*	WP, D, or SL 1.66 oz/100 lb	Apply dry or as a slurry and mix thoroughly with seed.	
Dwarf bunt (*Tilletia contraversa*)	Hexachlorobenzene	—*	WP, D, or SL 0.3 oz plus 1.6 oz maneb, SL or dry/100 lb; or 1.6-3.3 oz plus equal amounts of captan and maneb, for planter box.		
	Thiabendazole	—*	FL 2.2-3.3 oz/100 lb	Apply as a liquid or slurry. Keep dispersion under constant agitation.	Only for use on winter wheat in Colorado, Idaho, Montana, Oregon, Utah, Washington, and Wyoming.
Flag smut (*Urocystis tritici* or *U. agropyri*)	Formaldehyde	—*	L 0.37 lb/40 gal water	Seed dip or sprinkle and mix seed.	
	Hexachlorobenzene	—*	WP, D, or SL 0.3 oz plus 1.6 oz maneb, SL or dry/100 lb; or 1.6-3.3 oz plus equal amounts of captan and maneb, for planter box.		
Loose smut (*Ustilago tritici*)	Carboxin	—*	D, L, or SL 1.5-2.2 oz/100 lb		
Powdery mildew (*Erysiphe graminis tritici*)	Triadimefon	21	WP 1-2 oz/at least 5 gal water by aircraft or 10 gal water by ground/acre.	Apply at first sign of disease and when new powdery mildew symptoms reappear, 1 or 2 applications.	Total amount of triadimefon should not exceed 8 oz per acre per crop season.

* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
WHEAT					
Stripe, Stem, and Leaf rusts (*Puccinia striiformis*, *P. graminis tritici*, and *P. recondita*)	Sulfur	NTL**	WP or D 25-40 lb/acre	Apply to any part of plant; repeat in 7-10 days.	Limit: 50 lb/acre.
	Triadimefon	21	WP 3-4 oz/at least 5 gal water by aircraft or 10 gal water by ground/acre.	Use in areas of severe infection, 1 or 2 applications.	Total amount of triadimefon should not exceed 8 oz per acre per crop season.
	Zineb	3-4 weeks	WP 1.1-1.5 lb/100 gal	Begin when plants are in boot or early heading stage, or when rust is first reported in the area; repeat at 7-10-day intervals until milk stage.	Do not apply within 3-4 weeks of harvest.
Leaf blights, blotch and spot (*Helminthosporium* and *Septoria* spp.)	Copper hydroxide	NTL**	WP 0.81-1.08 lb/acre	Begin at early heading stage; repeat 10 days later.	
	Mancozeb	26	WP, D, or F 1.6 lb/acre in sufficient water for thorough coverage.	Begin in tillering to jointing stages; repeat at 7-10-day intervals.	Do not make more than 3 applications/season. Do not apply within 26 days of harvest. Do not graze treated areas within 26 days after last application.
Seedling blights and seed rots	Captan	--*	WP, D, or SL SL: 0.6-2.0 oz/100 lb Dry: 0.6-2.0 oz/100 lb	Apply dry or as a slurry and mix thoroughly with seed.	For the remainder of the chemicals on this page: Seed treatment only. Do not use treated seed for food or feed.
	Carboxin	--*	WP or SL 1.5-2.2 oz/100 lb		
	Maneb	--*	SL 1.2-3.3 oz/100 lb D 1.5-2.7 oz/100 lb	In seed treater. In planter box.	
	PCNB	--*	L 0.8 oz/100 lb		
	PCNB-Etridiazole (4:1)	--*	L 1.0 oz/100 lb		
	Thiram	--*	WP, D, or SL 1.66 oz/100 lb		
	Mancozeb	--*	WP or D 1.8-2.7 oz/100 lb		
	Metalaxyl (*Pythium* spp. damping-off only)	--*	WP 0.2-0.5 oz/100 lb	Apply as a slurry and mix thoroughly with seed.	

* Does not apply.
** No time limit.

FLOWER AND ORNAMENTAL DISEASES

by

Duane L. Coyier

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ALTERNATIVE CONTROL MEASURES

Disease control by means other than chemicals is feasible in selected cases, and dependence on fungicide applications often would be reduced by improved use of existing knowledge.

Disease development in plants depends upon the interaction of a susceptible host with a suitable pathogen in a favorable environment. When all of these factors are optimum, an epidemic occurs.

Reducing the intensity of one or more of the factors results in a corresponding decrease in disease severity. Chemical controls commonly are directed toward adversely affecting the disease-causing agent (pathogen). Alternative control measures may involve the other factors.

Host Resistance

Resistant cultivars should be selected carefully. Plant breeders often have developed cultivars resistant to pathogens that have been identified. Selection of resistant hosts is not necessarily a permanent solution to the disease problem, however. The host-pathogen interaction is changing constantly, and new strains of pathogens may attack readily previously resistant host plants.

Pathogen-free Planting Stock

Control of rose virus diseases is a good example of the benefits of pathogen-free planting stock. Virus-free planting stock must be used because there is no practical means of eliminating viruses from established plants. Common rose viruses can be eliminated by a heat-treatment technique, and, once treated, the plants remain virus-free until recontaminated by budding or grafting to a source of infected material. No vectors are known for these viruses. Virus-free rose plants have grown more vigorously and produced more flowers than their virus-infected counterparts.

The use of tissue culture of plant materials to obtain virus-free plants is becoming increasingly popular. The virus often does not keep pace with the development of new tissue produced at the growing points, and this phenomenon is exploited to obtain virus-free plants. Similar techniques are used to free plants of bacterial and fungal pathogens.

Biological Control

The growth of microflora in soils and on plant surfaces is governed by many factors, including interactions among the various microorganisms. Some fungi and bacteria produce metabolites that influence the development of surrounding microflora. This is readily demonstrated by the introduction of pathogens into sterilized soil. Without competition from other microbes, the pathogen may develop rapidly and cause severe infection of susceptible host plants.

Microbial antagonism is the basis for a new method of biocontrol of crown gall, a bacterial disease whose pathogen has a wide host range. Host plant roots are treated with nonpathogenic bacteria before outplanting. These bacteria colonize the root system and inhibit subsequent infection by pathogenic gall-forming bacteria.

Mycorrhizal fungi also influence host plant susceptibility to disease. Colonization of host roots by mycorrhizal fungi increases nutrient uptake in some plants, often with a corresponding increase in disease tolerance. In other systems, mycorrhizal fungi may compete directly with pathogens to reduce severity of disease in the host.

Foliar microbes also act as antagonists to plant pathogens. Recently, fungi were discovered that invade the mycelium and spores of those fungi that cause powdery mildew on various plants. If conditions favoring these beneficial fungi can be determined and they can be inoculated successfully, this method may become a practical means of biological control.

Composting also may change the balance of host-pathogen-environment interactions. Infection of host plants by soilborne pathogens has been reduced by using composted hardwood bark as a planting medium. The composted bark presumably contains components unfavorable to the pathogen.

Temperatures attained during the composting process also may effectively pasteurize potting media. Many harmful fungi, bacteria, and other pests are killed when a temperature of 71°C (160°F) is maintained for 30 minutes.

Horticultural Practices

The implementation of good horticultural practices is often a major factor in disease prevention. Plants stressed by improper watering, fertilization, unsuitable planting medium, lack of good drainage, and other improper growing conditions often are predisposed to infection by disease-causing organisms. Avoidance of conditions that cause stress will improve plant quality and reduce the need for corrective measures.

Sanitation

Much of the need for disease control can be eliminated by good sanitation procedures. Infected plant parts should be removed and destroyed to prevent contamination of healthy plants. Since many soilborne pathogens can be disseminated on contaminated tools and equipment, these items must be cleaned thoroughly between use in different locations. If the introduction of pathogens is minimized, correspondingly fewer control practices will be needed.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
AFRICAN VIOLET					
Botrytis blight (*Botrytis cinerea*)	Vinclozolin		0.25-0.50 lb WP/100 gal	Begin when conditions for disease prevail; repeat every 10-14 days during this period.	
Powdery mildew (*Oidium* sp.)	Dinocap		1.17-1.56 oz WP/100 gal field; 0.78-1.17 oz WP/100 gal greenhouse	Begin when disease first appears; repeat at 7-10-day intervals.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F.
Stem rot (*Rhizoctonia* sp.)	PCNB		1.5 lb WP/300 gal/1,000 sq ft of bed space	Apply to a well prepared seedbed before planting.	
	Thiophanate-methyl + Etridiazole (5:3)		2.4-4.8 oz WP/100 gal/400 sq ft	Drench-See manufacturer's label.	Irrigate immediately after treatment with additional water to at least 1/2 the volume of the fungicidal drench.
ASTER					
Botrytis flower blight and Stem rot (*Botrytis cinerea*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Iprodione		0.5-1.0 lb WP/100 gal	Apply when conditions favor disease development and continue as needed at 10-14-day intervals.	
	Zineb		1.125-1.5 lb WP/100 gal; 2.0-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Downy mildew (*Basidiophora endospora*)	Zineb		Same as for Botrytis	See above.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ASTER					
Powdery mildew (*Erysiphe cichoracearum*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Dinocap		1.17-1.56 oz WP/100 gal field; 0.78-1.17 oz WP/100 gal greenhouse	Begin when mildew appears; repeat at 7-10-day intervals.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F.
	Folpet		1.0 lb WP/100 gal	Begin before mildew appears; repeat at 7-10-day intervals.	
	Zineb		Same as for Botrytis	Same as for Botrytis.	
Leaf spots (*Septoria*, *Ascochyta*, and *Stemphylium* spp.)	Ferbam		0.76-1.14 lb WP/100 gal; Dust to cover/acre	Begin after plants are well established and before diseases appear; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
	Zineb		1.125-1.50 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when diseases threaten or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Root rot (*Pythium* sp., *Phytophthora* sp.)	Thiophanate-methyl + Etridiazole (5:3)		1.6-3.2 oz WP/100 gal/800 sq ft	Drench-See manufacturer's label.	Irrigate immediately after treatment with additional water to at least 1/2 the volume of fungicidal drench.
Root rot (*Rhizoctonia* sp.)	Iprodione		0.2 lb WP/100 gal	Drench-Apply 1-2 pints per sq ft of bed; repeat at 14-day intervals as needed.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ASTER Rust (*Coleosporium solidaginis*)	Triadimefon		0.5-1.0 oz/100 gal	Apply full coverage spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
	Triforine		2.4-3.6 oz EC/100 gal	Begin when disease first appears; repeat at 7-10-day intervals. Use high rate and short interval when disease is severe.	
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
AZALEA AND RHODODENDRON Petal blight (*Ovulinia azaleae*)	Benomyl		8 oz WP/100 gal; 4-8 oz WP/acre	Begin as flowers open; repeat at 10-14-day intervals during bloom.	
	Chlorothalonil		1.125 lb WP/100 gal	Begin at early bloom; repeat at 7-14-day intervals during bloom.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Ferbam		0.76-1.14 lb WP/100 gal; Dust to cover/acre	Begin after plants are well established and before disease appears. Apply at 3-4-day intervals during bloom to plants, flowers, and litter around plants.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
AZALEA AND RHODODENDRON					
Petal blight (*Ovulinia azaleae*) (con.)	Mancozeb		1.2 lb WP/100 gal	Apply 2-3 times a week while flowers are opening. Direct spray into flowers and spray ground under bushes thoroughly.	
	PCNB		0.25 lb EC/10 gal water/50 sq ft	Spray ground under plants and the surrounding area. Begin 4 weeks before bloom; repeat at 3-4-week intervals during bloom.	
	Thiophanate-methyl + Mancozeb (3:12)		0.75 lb WP/100 gal	Begin as flowers open.	
	Thiram		0.65 lb WP/100 gal	Begin when first blooms open; repeat at 5-10-day intervals through blooming period. Thoroughly wet plant surfaces including blossoms. Soak ground and litter around plants.	
	Triadimefon		2-4 oz WP/100 gal	Begin when buds show color; repeat at 7-14-day intervals as needed during bloom.	Treatment intervals for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter.
	Zineb		1.125 lb WP/100 gal; 2-2.6 lb WP or D/acre	Apply 2-3 times a week while flowers are opening. Spray flowers, soil, and litter around plants.	
Phytophthora dieback (*Phytophthora* spp.)	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-day intervals during periods of wet weather or severe disease incidence.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Metalaxyl		0.31-0.62 oz EC/100 gal	Spray to runoff; repeat at 2-3-week intervals if necessary.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
AZALEA AND RHODODENDRON					
Phytophthora root and crown rot (*Phytophthora* spp.)	Etridiazole		1-2 oz EC/100 gal/ 400 sq ft	Soil drench-See manufacturer's label.	Irrigate immediately with additional water to at least 1/2 the volume of the fungicidal drench.
	Metalaxyl		0.25-0.62 oz EC/100 gal/400-800 sq ft	Soil drench-See manufacturer's label.	Do not apply repeat soil applications of .62 oz a.i./100 gal closer than every 3 months, and do not exceed a total of 1 oz a.i. in 6 months.
BEGONIA					
Botrytis blight (*Botrytis cinerea*)	Vinclozolin		0.25-0.50 lb WP/100 gal	Begin applications when conditions for disease prevail; repeat every 10-14 days during this period.	
Damping-off and Tuber rot (*Pythium* spp. and *Rhizoctonia* spp.)	Captan		2 lb WP/100 gal	Dip tubers 30 minutes, drain, and plant.	For tuberose begonias.
	PCNB		1.5 lb WP/300 gal/ 1,000 sq ft	Soil drench.	Apply to a well prepared seedbed.
Powdery mildew (*Erysiphe cichoracearum*)	Cycloheximide		5 level tablespoons of 0.027% WP/gallon water	Spray all leaf and stem surfaces. Begin when disease first appears; repeat at 3-7-day intervals.	
	Dinocap		1.17-1.56 oz WP/100 gal field; 0.78-1.17 oz WP/100 gal greenhouse	Begin when disease first appears; repeat at 7-10-day intervals.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F.
	Dodemorph acetate		12.0 oz EC/100 gal	Spray plants at weekly intervals until disease is under control.	Undiluted product may cause severe eye damage. See manufacturer's label.
	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse application should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CALENDULA					
Powdery mildew (*Erysiphe* spp.)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Dinocap		1.17-1.56 oz WP/100 gal field; 0.78-1.17 oz WP/100 gal greenhouse	Begin when disease first appears; repeat at 7-14-day intervals.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F.
	Triforine		2.4-3.6 oz EC/100 gal	Begin when disease first appears; repeat at 7-10-day intervals. Use high rate and short interval when disease is severe.	
CAMELLIA					
Petal blight (*Sclerotinia camelliae*)	Captan		0.5 lb WP/100 gal	Apply to drench soil around plants, beginning when flowers start to open; repeat at 7-14-day intervals through bloom.	
	Ferbam		0.76-1.14 lb WP/100 gal; Dust to cover/acre	Apply as a monthly soil drench and to soil and litter around plants at 3-4-day intervals during bloom.	
	Mancozeb		1.2 lb WP/100 gal	Apply 2-3 times a week while flowers are opening. Direct spray on ground under bushes thoroughly.	
	PCNB		0.25 lb WP or EC/10 gal water/50 sq ft	Begin before buds open. Apply to soil and litter beneath bushes and to surrounding soil; repeat at 3-4-week intervals during blooming period.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CAMELLIA Petal blight (*Sclerotinia camelliae*) (con.)	Triadimefon		2-4 oz WP/100 gal	Begin when buds show color and repeat at 7-14-day intervals as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
	Ziram		1.4-1.52 lb WP/ 100 gal	Begin when flowerbuds start to swell; repeat at 7-10-day intervals. Apply as a drench to mulch and litter beneath and around bushes.	
Root rot (*Phytophthora cinnamomi*)	Thiophanate-methyl + Etridiazole (5:3)		2.4-4.8 oz WP/ 100 gal/400 sq ft	Drench-See manufacturer's label.	Irrigate immediately after treatment with additional water to at least 1/2 the volume of the fungicidal drench.
CARNATION Alternaria blight (*Alternaria dianthi*)	Captan		1 lb WP/100 gal	Begin at first sign of disease; repeat at 7-10-day intervals. Shorten intervals during frequent rains and heavy dews.	
	Chlorothalonil		1.125 lb WP/ 100 gal	Begin at first sign of disease; repeat at 7-day intervals during periods of wet weather or severe disease incidence.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Ferbam		0.76-1.14 lb WP/ 100 gal; Dust to cover/acre	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
	Folpet		0.5-1.0 lb WP/ 100 gal	Begin 2 weeks after planting; repeat at 7-10-day intervals as necessary.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CARNATION					
Alternaria blight (*Alternaria dianthi*) (con.)	Mancozeb		1.2 lb WP/100 gal	Begin when plants have leafed out; repeat at 7-10-day intervals.	
	Zineb		1.125 lb WP/ 100 gal	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Rust (*Uromyces caryophyllinus*)	Captan		1 lb WP/100 gal	Begin at first sign of disease; repeat at 7-10-day intervals. Shorten intervals during periods of frequent rains or heavy dews.	
	Ferbam		0.76-1.14 lb WP/ 100 gal; Dust to cover/acre	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
	Triadimefon		0.5-1.0 oz WP/100 gal	Apply full coverage spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouses during winter months. Not labeled for use in California.
	Triforine		2.4-3.6 oz EC/ 100 gal	Begin when disease first appears; repeat at 7-10-day intervals. Use high rate and short interval when disease is severe.	
Botrytis blight (*Botrytis cinerea*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-day intervals during periods of wet weather or severe disease incidence.	May produce temporary allergic side effects to workers. See manufacturer's label for details.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CARNATION					
Botrytis blight (*Botrytis cinerea*) (con.)	Iprodione		0.5-1.0 lb WP/100 gal	Apply as a foliar spray when conditions favor disease development.	
	Vinclozolin		0.25-0.50 lb WP/100 gal	Begin when conditions for disease prevail; repeat every 10-14 days during this period.	
	Zineb		1.125-1.5 lb WP/100 gal	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Leaf spot (*Septoria dianthi*)	Ferbam		0.76-1.14 lb WP/100 gal	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
	Mancozeb		1.2 lb WP/100 gal	Begin when plants have leafed out; repeat at 7-10-day intervals.	
	Zineb		1.125-1.5 lb WP/100 gal	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Powdery mildew (*Oidium* sp.)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Triadimefon		0.5-1.0 oz WP/100 gal	Apply full coverage spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter months. Not labeled for use in California.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CARNATION Powdery mildew (*Oidium* sp.) (con.)	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Fusarium root rot (*Fusarium* spp.)	Thiophanate-methyl + Etridiazole (5:3)		1.0-4.8 oz WP/100 gal/400 sq ft	Drench-See manufacturer's label.	Irrigate immediately after treatment with additional water to at least 1/2 the volume of the fungicidal drench.
	Zineb (greenhouse)		0.2 lb WP/12.5 gal/100 sq ft of bench space	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals.	
CHRYSANTHEMUM Leaf spots (*Septoria* spp. and *Cylindrosporium chrysanthemi*)	Captan		1 lb WP/100 gal	Apply at first sign of disease; repeat at 7-10-day intervals.	
	Chlorothalonil		1.125 lb WP/100 gal	Begin when cuttings are transplanted; repeat at 7-10-day intervals.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Ferbam		0.76-1.14 lb WP/100 gal; Dust to cover/acre	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
	Folpet		0.5-1.0 lb WP/100 gal	Begin immediately after planting; repeat at 7-10-day intervals, more frequently during rains or high humidity.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CHRYSANTHEMUM Leaf spots (*Septoria* spp. and *Cylindrosporium chrysanthemi*) (con.)	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/ acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
	Ziram		1.14-1.52 lb WP/ 100 gal	Apply at 7-10-day intervals as needed.	
Ascochyta ray blight (*Mycosphaerella ligulicola*)	Chlorothalonil		1.125 lb WP/100 gal	Begin when cuttings are transplanted; repeat at 7-10-day intervals.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Iprodione		0.5-1.0 lb WP/ 100 gal	Apply as foliar spray when conditions favor disease development. Repeat at 7-10-day intervals.	
	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/acre	Apply at 14-day intervals during bloom.	
Botrytis blight (*Botrytis cinerea*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Captan		1 lb WP/100 gal	Apply at first sign of disease; repeat at 7-10-day intervals.	
	Chlorothalonil		1.125 lb WP/100 gal	Apply pre-bloom and repeat at 7-10-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	DCNA		0.28-0.56 lb WP/ 100 gal; 0.64-1.8 lb WP or D/acre	Treat foliage and flowers at 7-14-day intervals.	For cuttings, see manufacturer's label.
	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development; repeat at 10-14-day intervals.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CHRYSANTHEMUM					
Botrytis blight (*Botrytis cinerea*) (con.)	Mancozeb		0.8-1.6 lb WP/100 gal; 0.8-1.6 lb WP or D/acre	Apply twice weekly during blooming season.	
	Vinclozolin		0.25-0.50 lb WP/100 gal	Begin when conditions for disease prevail; repeat every 10-14 days during this period.	
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Damping-off (*Rhizoctonia* sp.)	DCNA		1 lb WP/100 gal; Dust to cover/acre	Dip, drain, and plant cuttings or dust thoroughly and plant.	
	Thiophanate-methyl + Etridiazole (5:3)		2.4-4.8 oz WP/100 gal/400 sq ft	Drench-See manufacturer's label.	Irrigate immediately after treatment with additional water to at least 1/2 the volume of the fungicidal drench.
Powdery mildew (*Erysiphe cichoracearum*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Cycloheximide		5 level tablespoons of 0.027% WP/gallon water	Spray all leaf and stem surfaces. Begin when disease first appears; repeat at 3-7-day intervals.	
	Dinocap		1.17-1.56 oz WP/100 gal field; 0.78-1.17 oz WP/100 gal greenhouse	Begin when disease first appears; repeat at 7-10-day intervals.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F.
	Dodemorph acetate		12.0 oz EC/100 gal	Treat on 10-14-day schedule when conditions favor disease. Treat weekly under severe disease conditions.	
	Piperalin		4.0 oz EC/100 gal	Treat on 7-10-day schedule.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CHRYSANTHEMUM					
Powdery mildew (*Erysiphe cichoracearum*) (con.)	Triadimefon		0.5-1.0 oz WP/ 100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse application should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
Rust (*Puccinia chrysanthemi*)	Captan		1 lb WP/100 gal	Apply at first sign of disease; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
	Ferbam		0.76-1.14 lb WP/ 100 gal; Dust to cover/ acre	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
	Mancozeb		1.2 lb WP/100 gal	Begin when plants have leafed out; repeat at 7-10-day intervals.	
	Nabam with Zinc sulfate		1.05 lb LC nabam with 0.28 lb WP zinc sulfate/100 gal	Begin before disease appears or at first sign of disease; repeat at 7-10-day intervals, more frequently under severe disease conditions.	
	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse application should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/ acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CYCLAMEN					
Botrytis blight (*Botrytis* sp.)	Benomyl		4 oz WP/100 gal: 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Ferbam		0.76-1.14 lb WP/100 gal; Dust to cover/acre	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development; repeat at 10-14-day intervals.	
	Vinclozolin		0.25-0.50 lb WP/100 gal	Begin when conditions for disease prevail; repeat every 10-14 days during this period.	
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
DAFFODIL	(See Narcissus and Daffodil)				
DAHLIA					
Botrytis blight (*Botrytis cinerea*)	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development.	
	Mancozeb		1.2 lb WP/100 gal	Begin when plants have leafed out; repeat at 7-10-day intervals.	
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
DAHLIA Powdery mildew (Erysiphe cichoracearum)	Benomyl		4 oz WP/100 gal: 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Dinocap		1.17-1.56 oz WP/ 100 gal field; 0.78-1.17 oz WP/ 100 gal greenhouse	Begin when disease first appears; repeat at 7-10-day intervals.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F.
	Piperalin		4.0-8.0 oz EC/ 100 gal	Spray as directed on label every 7-10 days, or as needed.	
	Triadimefon		0.5-1.0 oz WP/ 100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
	Triforine		2.4-3.6 oz EC/ 100 gal	Begin when disease first appears; repeat at 7-10 days as needed.	
DELPHINIUM Powdery mildew (Erysiphe polygoni)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Dinocap		1.17-1.56 oz WP/ 100 gal field; 0.78-1.17 oz WP/ 100 gal greenhouse	Begin when disease first appears; repeat at 7-10-day intervals.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F.
	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/ acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
DELPHINIUM					
Botrytis blight (*Botrytis cinerea*), Cercospora leaf spot (*C. delphinii*), Septoria leaf spot (*S. delphinella*), and Rust (*Puccinia recondita*)	Benomyl		4 oz WP/100 gal: 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	For Botrytis blight only.
	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development.	For Botrytis blight only.
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
DIEFFENBACHIA					
Bacterial stem rot (*Erwinia* sp.)	Streptomycin sulfate		100 p/m solution, L	Spray stock plants at 5-7-day intervals. Soak cuttings for 20 minutes in 200 p/m solution and plant in sterile rooting medium.	
Botrytis blight (*Botrytis cinerea*)	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development.	
	Vinclozolin		0.25-0.50 lb WP/100 gal	Begin when conditions for disease prevail; repeat every 10-14 days during this period.	
Stem rot (*Phytophthora palmivora*, *Pythium splendens*)	Metalaxyl		0.12-0.31 oz EC/100 gal/ 400-800 sq ft	Apply as drench to 400-800 sq ft of bed or bench area; repeat at 2-3-month intervals as necessary.	
	Thiophanate-methyl + Etridiazole (5:3)		1.0-4.8 oz WP/100 gal/400 sq ft	Drench-See manufacturer's label.	Irrigate immediately after treatment with additional water to at least 1/2 the volume of the fungicidal drench.
Root and Cane rot (*Rhizoctonia solani*)	Thiophanate-methyl + Etridiazole (5:3)		1.0-4.8 oz WP/100 gal/400 sq ft	Drench-See manufacturer's label.	Irrigate immediately after treatment with additional water to at least 1/2 the volume of the fungicidal drench.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
DOGWOOD					
Botrytis blight (*Botrytis cinerea*)	Benomyl		4 oz WP/100 gal: 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Zineb		1.125-1.5 lb WP/100 gal	Apply at bud break; repeat 7-12 days later.	
Anthracnose (*Elsinoe corni*)	Benomyl		8 oz WP/100 gal; 4-8 oz WP/acre by air	Begin application at bud break and make 2 or 3 additional applications at 10-14-day intervals.	
	Mancozeb		1.2 lb WP/100 gal	Apply when buds begin to open; repeat when bracts have fallen, 4 weeks later, and in late summer after flower buds are formed.	
	Maneb		0.8-1.2 lb WP/100 gal	Begin when buds open; repeat when bracts fall, 4 weeks later, and in late summer.	
Leaf spot (*Septoria cornicula* and *S. floridae*)	Benomyl		0.5 lb WP/100 gal	Begin when buds open; repeat when bracts fall, 4 weeks later, and in late summer.	
	Chlorothalonil		1.125 lb WP/100 gal	Begin at early bloom and repeat at 7-14 days as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
EUONYMUS					
Botrytis blight (*Botrytis cinerea*)	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development.	
Leaf spots (*Cercospora* spp., *Exosporium* sp., *Phyllosticta* spp., *Septoria* spp., *Ramularia* sp., and *Marssonina* sp.)	Zineb		1.125-1.5 lb WP/100 gal	Apply at bud break; repeat 7-12 days later.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
EUONYMUS					
Powdery mildew (*Microsphaera alni*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Dinocap		1.56 oz WP/100 gal	Begin when disease first appears; repeat at 7-10-day intervals or as necessary.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F.
	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
	Triforine		2.4-3.6 oz EC/100 gal	Begin when disease first appears; repeat at 7-10 days as needed.	
	Zineb		1.125-1.5 lb WP/100 gal	Apply at bud break; repeat 7-12 days later.	
FIRETHORN	(See Pyracantha)				
GARDENIA					
Botrytis, or bud rot, and Leaf spot (*Botrytis cinerea*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Ferbam		0.76-1.14 lb WP/100 gal; Dust to cover/acre	Begin when plants are well established and before disease appears; repeat at 3-4-day intervals until bloom and after bloom as necessary.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
GARDENIA					
Powdery mildew (*Erysiphe polygoni*)	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
GERANIUM					
Alternaria leaf spot (*Alternaria tenuis*)	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Botrytis gray mold (*Botrytis cinerea*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	DCNA		0.28-0.56 lb WP/100 gal	Spray, dip, or dust to cover stock, greenhouse plants, and cuttings. Begin when disease is anticipated or first appears. Spray foliage and flowers at 7-14-day intervals or 5-7-day intervals during cool, damp weather.	
	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development.	
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
GERANIUM					
Rust (*Puccinia pelargonii-zonalis*)	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Oxycarboxin		0.75-1.125 lb WP/100 gal	Begin when first sign of disease appears; repeat at 2-week intervals. Use 2-4 sprays per season.	Do not exceed 4 applications per season. For use in greenhouses.
	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
GLADIOLUS					
Botrytis gray mold (*Botrytis cinerea* and *B. gladiolorum*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Ferbam		1.5 lb WP/100 gal	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development.	
	Mancozeb		1.2 lb WP/100 gal; 1.2-1.8 lb WP/acre	Apply weekly before disease appears. Increase to 2 or 3 applications per week after disease appears and during wet weather.	Reduce dosage to 1/2 strength during flowering period.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
GLADIOLUS					
Botrytis gray mold (Botrytis cinerea and B. gladiolorum) (con.)	Thiram		5% D/acre	Dust corms lightly. Plant immediately after treatment. Dust and mix with covering soil.	
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when foliage appears; repeat at 3-7-day intervals until spikes form.	
Corm rots and decay	Captan		0.25-0.75 lb WP/100 gal	Dip corms 20-30 minutes, drain, and plant.	
	Thiabendazole		0.9 lb WP or FL/100 gal	See manufacturer's label.	
	Thiram		5% D/acre	Dust corms lightly. Plant immediately after treatment. Dust and mix with covering soil.	
Leaf spots (Alternaria sp., Curvularia lunata, Septoria gladioli, and Stemphylium sp.)	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details. For Curvularia only.
	Ferbam		0.76-1.14 lb WP/100 gal; Dust to cover/acre	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals until bloom and after bloom as necessary.	For Septoria and Stemphylium only.
	Mancozeb		1.2 lb WP/100 gal; 1.2-1.8 lb WP/acre	Apply weekly before disease appears. Increase to 2 or 3 applications per week after disease appears and during wet weather.	Reduce dosage to 1/2 strength during flowering period. For Curvularia only.
	Maneb		1.2 lb WP/100 gal; 1.7-2.2 lb WP or D/acre	Begin when flowering spikes are developing; repeat 2-3 times at weekly intervals.	For Curvularia and Stemphylium only.
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when foliage appears; repeat at 3-7-day intervals until spikes form.	
	Ziram		1.14-1.52 lb WP/100 gal	Apply at weekly intervals.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
HOLLYHOCK					
Anthracnose (*Colletotrichum malvarum*)	Captan		2.1 lb D/acre	Apply as a dust before disease appears; repeat at weekly intervals during warm, wet weather.	
	Mancozeb		1.2 lb WP/100 gal	Begin when plants have leafed out; repeat at 7-10-day intervals.	
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Leaf spots	Mancozeb		1.2 lb WP/100 gal	Begin when plants have leafed out; repeat at 7-10-day intervals.	
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Powdery mildew (*Erysiphe* spp.)	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
Rust (*Puccinia malvacearum*)	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Ferbam		0.75-1.12 lb F/100 gal	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
	Mancozeb		1.2 lb WP/100 gal	Begin when plants have leafed out; repeat at 7-10-day intervals.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
HOLLYHOCK Rust (*Puccinia malvacearum*) (con.)	Triadimefon		0.5-1.0 oz WP/ 100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/ acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
HYACINTH Bulb rot (*Botrytis* and *Fusarium* spp.)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	For Botrytis blight only.
	Thiram		1.6 oz/gal water as SL; 5-12% D/acre	Dust bulbs lightly with 5-12% D or use 1.6 oz/gal water as a SL. Plant immediately, dry for storage, or dust and mix with covering soil.	
HYDRANGEA Botrytis gray mold (*Botrytis cinerea*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	DCNA		1 lb WP/100 gal; 1.8 lb WP or D/ acre	Apply before lifting for shipment or storage. Begin before disease appears.	
	Iprodione		0.5-1.0 lb WP/ 100 gal	Apply as foliar spray when conditions favor disease development.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
HYDRANGEA					
Botrytis gray mold (*Botrytis cinerea*) (con.)	Vinclozolin		0.25-0.50 lb WP/100 gal	Begin when conditions for disease prevail; repeat every 10-14 days during this period.	
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Leaf spots (*Cercospora arborescentis* and *Septoria hydrangeae*)	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
Powdery mildew (*Erysiphe polygoni*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Dinocap		1.17-1.56 oz WP/100 gal field; 0.78-1.17 oz WP/100 gal greenhouse	Begin when disease first appears; repeat at 7-10-day intervals.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F.
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Rust (*Pucciniastrum hydrangeae*) and Leaf spots	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
IRIS					
Botrytis flower blight (*Botrytis cinerea*)	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development.	
Botrytis leaf blight (*Botrytis* sp.), Alternaria leaf spot (*Alternaria* sp.), and Rust (*Puccinia iridis*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	For Botrytis only.
	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	Not for rust. May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Zineb		1.125-1.5 lb WP/100 gal; 2-2 6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Fusarium basal rot (*Fusarium* spp.)	Thiabendazole		0.9 lb WP or FL/100 gal	See manufacturer's label.	
Leaf spot (*Didymellina macrospora*), Ascochyta and Phomopsis blights	Benomyl		8 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Folpet		1 lb WP/100 gal	Begin when plants emerge; repeat at 7-10-day intervals.	For Didymellina only.
	Mancozeb		1.2 lb WP/100 gal	Full coverage sprays. Begin when plants are well leafed out; repeat at 7-10-day intervals as long as necessary.	For Didymellina only.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
IVY, BOSTON					
Leaf spots	Ferbam		0.76-1.14 lb WP/ 100 gal; Dust to cover/ acre	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals as necessary.	
IVY, ENGLISH					
Leaf spot and twig blight (*Phyllosticta concentrica*) and Leaf spot and stem spot (*Amerosporium trichellum*)	Ferbam		0.76-1.14 lb WP/ 100 gal; Dust to cover/ acre	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals as necessary.	
	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/ acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
LAUREL					
Leaf spots	Ferbam		0.76-1.14 lb WP/ 100 gal; Dust to cover/ acre	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
LILAC					
Powdery mildew (*Microsphaera alni*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Dinocap		1.56 oz WP/100 gal	Begin when disease first appears; repeat at 7-10-day intervals as necessary.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F.
	Piperalin		4.0-8.0 oz EC/100 gal	Spray as directed on label every 7-10 days or as needed.	
	Triforine		2.4-3.6 oz EC/100 gal	Begin when disease first appears; repeat at 7-10 days as needed.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
LILAC Powdery mildew (*Microsphaera alni*) (con.)	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
	Zineb		1.125-1.5 lb WP/ 100 gal	Apply at bud break; repeat 7-12 days later.	
Leaf spot	Zineb		1.125-1.5 lb WP/ 100 gal	Apply at bud break; repeat 7-12 days later.	
LILY Botrytis blight (*Botrytis cinerea* and *B. elliptica*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Bordeaux mixture		6.0-7.0 lb (of 12.75% metallic copper) WP/100 gal	Begin in early spring before disease appears; repeat at 7-10-day intervals.	
	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development.	
	Mancozeb		1.2 lb WP/100 gal	Field coverage sprays. Begin when plants are well leafed out; repeat at 7-10-day intervals as long as necessary.	
	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/ acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high relative humidity.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
MARIGOLD					
Damping-off (*Rhizoctonia* sp.)	Iprodione		0.2 lb WP/100 gal	Drench at seeding. Apply 1-2 pints of diluted fungicide per sq ft.	
	Thiophanate-methyl + Etridiazole (5:3)		1.6-3.2 oz WP/100 gal/800 sq ft	Drench-See manufacturer's label.	Irrigate immediately after treatment with additional water to at least 1/2 the volume of the fungicidal drench.
Botrytis blight (*Botrytis cinerea*)	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development.	
Leaf blight (*Cercospora* spp.)	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
Rust (*Puccinia chrysanthemi*)	Ferbam		0.75-1.12 lb FL/100 gal	Apply at 7-10-day intervals during periods of rapid growth or high humidity.	
	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
NARCISSUS AND DAFFODIL					
Bulb rot (*Botrytis* and *Fusarium* spp.)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	For Botrytis only.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
NARCISSUS AND DAFFODIL Bulb rot (Botrytis and Fusarium spp.) (con.)	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development.	For Botrytis only.
	Thiabendazole		0.9 lb WP or F/ 100 gal	See manufacturer's label.	For Fusarium only.
	Thiram		1.6 oz/gal water as SL; 5-12% D/acre	Dust bulbs lightly with 5-12% D or use 1.6 oz/gal water as a SL. Plant immediately, dry for storage, or dust and mix with covering soil.	
	Vinclozolin		0.75-1.0 lb WP/ 100 gal	Bulb dip.	For Botrytis only.
ORCHID Brown spot (Phytomonas cattleyae), Heart rot and leaf black rot (Phytophthora cactorum), and Root rot (Rhizoctonia solani)	8-Quinolinol sulfate		390 p/m solution in water (1 oz 5% formulation/gal) + spreader sticker	Dip infected plants, including growing media and pots, for 1 hr; repeat in 1 week if disease persists.	
PACHYSANDRA Volutella blight (Volutella pachysandrae)	Mancozeb		1.6 lb WP/50 gal/ 5,000 sq ft	Begin at first sign of disease; repeat at about 10-14-day intervals for a minimum of 5 applications.	
PANSY Anthracnose (Colletotrichum violae-tricoloris)	Mancozeb		1.2 lb WP/100 gal	Full coverage sprays. Begin when plants are well leafed out; repeat at 7-10-day intervals as long as necessary.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PANSY					
Anthracnose (*Colletotrichum violae-tricoloris*) (con.)	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Botrytis blight (*Botrytis cinerea*)	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray when conditions favor disease development.	
Powdery mildew (*Sphaerotheca macularis*) and Rust (*Puccinia violae*)	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
PEONY					
Botrytis blight (*Botrytis cinerea*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Bordeaux mixture		6.0-7.0 (of 12.75% metallic copper) WP/100 gal	Begin in early spring before disease appears; repeat at 7-10-day intervals.	
	Ferbam		0.76-1.14 lb WP/100 gal; Dust to cover/acre	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
	Mancozeb		1.2 lb WP/100 gal	Apply in early spring and early fall, drenching foliage and soil around plants. Destroy all infected plant parts promptly.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PEONY Botrytis blight (*Botrytis cinerea*) (con.)	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/ acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
PHILODENDRON Bacterial leaf spot (*Erwinia chrysanthemi*)	Streptomycin sulfate		200 p/m solution, L	Remove all decayed leaves. Spray with 200 p/m solution as a preventive or at first sign of water-soaked leaves; repeat at 4-5-day intervals.	
Phytophthora stem blight (*Phytophthora* sp.) and *Pythium* sp.	Metalaxyl		0.12-0.50 oz EC/ 100 gal/ 400-800 sq ft	Drench-See manufacturer's label.	
POINSETTIA Botrytis blight (*Botrytis cinerea*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Ferbam		0.76-1.14 lb WP/ 100 gal; Dust to cover/ acre	Begin after plants are well established and before disease appears; repeat at 7-10-day intervals until bloom and after bloom as necessary.	
	Vinclozolin		0.25-0.50 lb WP/ 100 gal	Foliar spray. Repeat every 10-14 days.	Do not spray poinsettias in color. At higher rates phytotoxicity may occur.
Pythium root rot (*Pythium* spp.)	Etridiazole		1-2 oz EC/100 gal/ 400 sq ft	Drench-See manufacturer's label.	Irrigate immediately after treatment with additional water to at least 1/2 the volume of the fungicidal drench.
	Fenaminosulf			See manufacturer's label.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
POINSETTIA					
Pythium root rot (*Pythium* spp.) (con.)	Metalaxyl		0.12-0.50 oz EC/ 100 gal/ 400-800 sq ft	Drench-See manufacturer's label.	Do not apply at rates of 0.37-0.50 oz a.i. more often than once every 6 weeks.
Stem rot (*Rhizoctonia solani*)	PCNB		1.5 lb WP/300 gal water/1,000 sq ft	Apply as a soil drench	Apply to a well prepared seedbed.
	Thiophanate-methyl + Etridiazole (5:3)		2.4-4.8 oz WP/100 gal/400 sq ft	Drench-See manufacturer's label.	Irrigate immediately after treatment with additional water to at least 1/2 the volume of the fungicidal drench.
PRIVET					
Dermatophora root rot (*Dermatophora* sp.) and Anthracnose leaf spots (*Glomerella cingulata*)	Bordeaux mixture		10 copper sulfate + 10 lime; WP, 5-5-50 for root rot/100 gal 4 copper sulfate + 4 lime; WP, 4-4-100 for leaf spots/100 gal	Spray base of shrub and surrounding soil when infection is detected. Begin in spring before new growth occurs; repeat 1 or 2 times as necessary.	
PYRACANTHA (FIRETHORN)					
Fireblight (*Erwinia amylovora*)	Streptomycin sulfate		100 p/m Solution, L	Begin spraying at start of blossom period; repeat at 3-4-day intervals during bloom and at 5-7-day intervals after bloom if weather favors disease spread.	
Scab (*Fusicladium pyracanthae*)	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
RHODODENDRON	(See Azalea and Rhododendron)				
ROSE					
Powdery mildew (Sphaerotheca pannosa var. rosae)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Cycloheximide		2 level tablespoons of 0.027% WP/gal water	Spray all leaf and stem surfaces. Begin when disease first appears; repeat at 7-day intervals, 3-5-day intervals if disease is severe.	For roses other than rambler.
	Dinocap		1.17-1.56 oz WP/100 gal field; 0.78-1.17 oz WP/100 gal greenhouse	Begin when disease appears; repeat at 4-7-day intervals in the greenhouse, and 7-10-day intervals in the field.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F. May cause chlorotic leafspot on some cultivars.
	Dodemorph acetate		12.0 oz EC/100 gal	Treat on 10-14-day schedule when conditions favor disease. Treat weekly under severe disease conditions.	Some varieties may be sensitive. See manufacturer's label. Undiluted product may cause severe eye damage.
	Folpet		0.5-1.0 lb WP/100 gal; 2.6 lb WP or D/acre	Begin when first leaves unfold; repeat at 7-10-day intervals through season.	Addition of wetting agents may cause injury to roses.
	Piperalin		4.0 oz EC/100 gal	Treat on 7-10-day schedule.	
	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter.
	Triforine		2.4-3.6 oz EC/100 gal	Begin when disease first appears; repeat at 7-10 days as needed.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ROSE					
Powdery mildew (*Sphaerotheca pannosa* var. *rosae*) (con.)	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/ acre	Begin when foliage first appears.	
Black spot (*Diplocarpon rosae*)	Chlorothalonil		1.125 lb F/ 100 gal; 0.75 lb WP/ 100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Folpet		0.5-1.0 lb WP/100 gal; 2.6 lb WP or D/acre	Begin when first leaves unfold; repeat at 7-10-day intervals through season.	Addition of wetting agents may cause injury to roses.
	Mancozeb		1-2 lb WP/100 gal; 1-2 lb WP or D/ acre	Apply as full coverage spray or dust, beginning when plants are well leafed out; repeat at weekly intervals.	
	Maneb		0.8-1.2 lb WP/100 gal; 1.2-2.1 lb WP or D/acre	Begin when first leaves unfold; repeat at 7-10-day intervals.	Not registered in California.
	NIA 9102		1.2 lb WP/100 gal	Apply when new growth first appears; repeat at 3-7-day intervals.	
	Triforine		2.4-3.6 oz EC/100 gal	Begin when disease first appears; repeat at 7-10-days as needed.	
	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/ acre	Begin when foliage first appears.	
Botrytis gray mold and Blossom blight (*Botrytis cinerea*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Captan		1 lb WP/100 gal; 2.25-3.0 lb WP or D/acre	Begin at first growth or at first sign of disease; repeat at 7-14-day intervals, more frequently during frequent rains or heavy dews.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ROSE					
Botrytis gray mold and Blossom blight (*Botrytis cinerea*) (con.)	Chlorothalonil		1.125 lb F/ 100 gal; 0.75 lb WP/ 100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Iprodione		0.5-1.0 lb WP/ 100 gal	Apply as foliar spray when conditions favor disease development.	
	Vinclozolin		0.25-0.50 lb WP/ 100 gal	Foliar spray. Repeat every 10-14 days.	
	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/acre	Begin when foliage first appears.	
Rust (*Phragmidium* sp.)	Maneb		0.8-1.2 lb WP/ 100 gal; 1.2-2.1 lb WP or D/acre	Begin when first leaves unfold; repeat at 7-10-day intervals.	
	Triforine		2.4-3.6 fl oz EC/100 gal	Begin when disease first appears; repeat at 7-10-day intervals as needed.	
	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/acre	Begin when foliage first appears.	
SNAPDRAGON					
Anthracnose (*Colletotrichum antirrhini*), Botrytis blight (*Botrytis cinerea*), Leaf spot (*Phyllosticta antirrhini*), and Downy mildew (*Peronospora antirrhini*)	Iprodione		0.5-1.0 lb WP/ 100 gal	Apply as foliar spray when conditions favor disease development.	For Botrytis only.
	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/ acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals (2-4-day intervals for downy mildew only), more frequently during periods of prolonged rainfall or high humidity.	
Damping-off (*Phytophthora* sp., *Pythium* sp., *Rhizoctonia* sp., and *Sclerotinia* sp.)	Etridiazole		0.75-1.0 oz EC/100 gal/800 sq ft	Drench-See manufacturer's label.	Irrigate immediately with water equal to at least 1/2 the volume of the fungicidal drench. For Pythium and Phytophthora only.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
SNAPDRAGON					
Damping-off (*Phytophthora* sp., *Pythium* sp., *Rhizoctonia* sp., and *Sclerotinia* sp.) (con.)	Iprodione		0.2 lb WP/100 gal	Drench at seeding or transplanting. Apply 1-2 pints of diluted fungicide solution per sq ft.	For Rhizoctonia only.
	Metalaxyl		0.12-0.50 oz EC/ 100 gal/ 800 sq ft	Drench at transplanting. See manufacturer's label.	For Pythium and Phytophthora only.
	PCNB		1.8-2.5 lb WP/ 300 gal water/ 1,000 sq ft	For Rhizoctonia, apply as a soil drench before planting. Thoroughly incorporate to a depth of 4 inches.	For Rhizoctonia only.
				For Sclerotinia, apply 1 week before planting.	For Sclerotinia only.
	Thiophanate-methyl + Etridiazole (5:3)		1.6-3.2 oz WP/ 100 gal/800 sq ft	Drench-See manufacturer's label.	Irrigate immediately after treatment with additional water to at least 1/2 the volume of the fungicidal drench. For Rhizoctonia only.
Powdery mildew (*Oidium* sp.)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Dinocap		1.17-1.56 oz WP/ 100 gal field; 0.78-1.17 oz WP/ 100 gal greenhouse	Begin when disease first appears; repeat at 7-10-day intervals.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F.
	Triadimefon		0.5-1.0 oz WP/ 100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
	Triforine		2.4-3.6 oz EC/ 100 gal	Begin when disease first appears; repeat at 7-10 days as needed.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
SNAPDRAGON Powdery mildew (*Oidium* sp.) (con.)	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	
Rust (*Puccinia antirrhini*)	Mancozeb		1-2 lb WP/100 gal; 1-2 lb WP/acre	Apply as full coverage spray, beginning when plants are well leafed out; repeat at weekly intervals.	
	Maneb		0.8-1.2 lb WP/100 gal; 1.2-2.4 lb WP or D/acre	Begin with emergence; repeat at 7-10-day intervals.	
	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
	Triforine		2.4-3.6 oz EC/100 gal	Begin when disease first appears; repeat at 7-10 days as needed.	
	Zineb		1.125-1.5 lb WP/100 gal; 2-2.6 lb WP or D/acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
TULIP					
Black rot (*Sclerotinia* sp.) and Crown rot (*Sclerotium rolfsii*)	PCNB		2.4-4.8 lb WP/ sufficient water/ 1,000 sq ft 3.4-4.5 lb WP/ 5-10 gal water/ 1,000 linear ft	Apply in broadcast preplanting treatment and mix into upper 6-7 inches of soil; or apply to bulbs and furrow at time of planting; or dip bulbs for 5 min in suspension of 46.5 lb WP/100 gal water to which 1.0% of suitable sticker has been added.	
	Vinclozolin		0.25-0.50 lb WP/ 100 gal	As foliar spray, use 0.25-0.50 lb/100 gal; repeat every 10-14 days. For bulb dip, use 0.75-1.0 lb/100 gal of water. Maintain suspension by agitation.	For Sclerotinia only.
Botrytis blight (*Botrytis tulipae*)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray to run-off when conditions favor disease; repeat at 10-14-day intervals as long as disease conditions are favorable.	
	Mancozeb		1.2 lb WP/100 gal	Full coverage sprays. Begin when plants are well leafed out; repeat at 7-10-day intervals as long as necessary.	
	Thiram		1.6 oz/gal water as a SL	Treat bulbs with slurry. Plant immediately or dry for storage.	
	Vinclozolin		0.25-0.50 lb WP/ 100 gal	As foliar spray, use 0.25-0.50 lb WP/100 gal; repeat every 10-14 days. For bulb dip, use 0.75-1.0 lb WP/100 gal of water. Maintain suspension by agitation.	
	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/ acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ZINNIA					
Damping-off (Phytophthora sp., Pythium sp., and Rhizoctonia sp.)	Etridiazole		0.75-1.0 oz EC/ 100 gal/ 800 sq ft	Mix diluted fungicide into top 2-3 in of soil at time of seeding according to manufacturer's label.	Irrigate immediately after treatment with additional water to at least 1/2 the volume of the fungicidal drench. For Phytophthora and Pythium only.
	Fenaminosulf		0.088-0.525 lb WP/ 100 gal	Drench-See manufacturer's label.	
	Iprodione		0.2 lb WP/100 gal	Drench at seeding or transplanting. Apply 1-2 pints of diluted fungicide solution per sq ft.	For Rhizoctonia only.
	Metalaxyl		0.06-0.12 oz EC/ 100 gal/800 sq ft	Drench at seeding-See manufacturer's label.	For Phytophthora and Pythium only.
Leaf blight (Alternaria zinniae) and Leaf spot (Cercospora zinniae)	Iprodione		0.5-1.0 lb WP/100 gal	Apply as foliar spray to run-off when conditions favor disease; repeat at 10-14-day intervals as long as disease conditions are favorable.	For Alternaria only.
	Mancozeb		1.2 lb WP/100 gal	Full coverage sprays. Begin when plants are well leafed out; repeat at 7-10-day intervals as long as necessary.	
	Maneb		0.8-1.2 lb WP/100 gal; 1.2-2.4 lb WP or D/acre	Begin when new growth appears; repeat weekly.	
	Triadimefon		0.5-1.0 oz WP/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. For Cercospora only. Not labeled for use in California.
	Zineb		1.125-1.5 lb WP/ 100 gal; 2-2.6 lb WP or D/ acre	Begin when disease threatens or before disease appears; repeat at 7-10-day intervals, more frequently during periods of prolonged rainfall or high humidity.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ZINNIA					
Powdery mildew (Erysiphe cichoracearum)	Benomyl		4 oz WP/100 gal; 4-8 oz WP/acre by air	Begin when disease first appears; repeat at 10-14-day intervals as necessary, more frequently under severe disease conditions.	
	Chlorothalonil		1.125 lb WP/100 gal	Begin at first sign of disease; repeat at 7-14-day intervals as needed.	May produce temporary allergic side effects to workers. See manufacturer's label for details.
	Dinocap		1.17-1.56 oz WP/100 gal field; 0.78-1.17 oz WP/100 gal greenhouse	Begin when disease first appears; repeat at 7-10-day intervals.	Apply with care when temperatures approach 85°F. Do not apply at temperatures over 90°F.
	Piperalin		4.0 oz EC/100 gal	Treat on 7-10-day schedule.	
	Triadimefon		0.5-1.0 oz EC/100 gal	Spray to the point of drip as needed.	Treatment interval for greenhouse use should not be less than 30 days. See manufacturer's label. Reduce dosage by 1/2 for use in greenhouse during winter. Not labeled for use in California.
	Triforine		2.4-3.6 oz EC/100 gal	Begin when disease first appears; repeat at 7-10 days as needed.	

FRUIT DISEASES

by

Donald J. Weaver

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ALTERNATIVE CONTROL MEASURES

In addition to the application of pesticides, certain practices can reduce or prevent losses from plant diseases in fruit crops. These practices vary depending upon the crop and the disease problem involved.

The use of disease-resistant or disease-tolerant fruit cultivars is the most practical method for preventing disease losses, and such cultivars should be used when they are available. Recently developed apple varieties (Prima, Priscilla, Sir Prize) have good resistance to apple scab, a widespread and destructive apple disease. Peach varieties (Harvester, Harbrite, and several others) highly resistant to the bacterial spot disease are also available. Disease-resistant fruit varieties should be selected carefully from nursery catalogs or other sources; these varieties also should be suitable for production in the geographic area in which they will be planted.

Sanitary practices also may help reduce the need for pesticides. Removal and disposal of diseased fruit and plant parts often reduce the rate of disease spread. Pruning treatments or other cultural practices that permit good air circulation can reduce disease incidence and improve penetration of pesticide sprays.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
APPLE					
Scab* (*Venturia inaequalis*)	Benomyl + Captan	NTL** NTL**	1-1.5 oz + 6-8 oz/100 gal	Apply at 1/2 in green tip and repeat at 7-14-day intervals (or as needed) through cover sprays.	Do not graze livestock in treated orchards. Spray injury may result if captan is used with, immediately before, or closely following an oil spray.
	Dodine	5	0.162-0.325 lb/100 gal 0.8-1.6 lb/acre	For protective schedule, begin at prebloom stage; repeat at 5-7-day intervals through first cover.	Do not graze or feed forage from treated areas. Do not use apples treated with dodine in manufacture of apple pomace for livestock feeds. Russetting may occur on Golden Delicious apples.
	Dinocap (4.7%) + Mancozeb (72.0%)	21	1.6 lb/100 gal 5.2 lb/acre	Apply every 6-7 days from the time first leaves appear until petal fall, then at 10-day to 2-week intervals for remainder of season.	Do not use within 7 days of an oil application.
	Folpet	NTL**	1.0 lb/100 gal 5.2 lb/acre		May cause injury to fruit finish.
	Mancozeb	21 or 30 depending on state	1.6 lb/100 gal 5.2 lb/acre		Do not graze or feed forage from treated areas.
	NIA 9102	15 or 30 depending on state	1.6 lb/100 gal 5.2 lb/acre		
Botryosphaeria rot (*Botryosphaeria ribis*) and Black rot (Frogeye leafspot) (*Physalospora obtusa*)	Captan	NTL**	1.0 lb/100 gal WP 2-3.75 lb/acre Dust	Late cover and preharvest periods.	Not compatible with oils or strong alkali such as lime or lime-sulfur.
	Ferbam	7	0.76-1.52 lb/100 gal 2.9-4.0 lb/acre	Begin at petal fall; repeat in cover sprays. Reduce to 0.6 lb/100 gal in late cover sprays.	Golden Delicious and other yellow varieties of apples are easily russetted by ferbam.
	Folpet	NTL**	0.75-1.0 lb/100 gal	Begin at delayed dormant; repeat at 7-14-day intervals through cover sprays. In Western States do not apply between bloom and July 1 to avoid injury.	Russetting may be caused on sensitive varieties in Eastern States when used from just before bloom to 30 days after petal fall.
	Thiram	NTL**	0.98-1.30 lb/100 gal 1.7-2.6 lb/acre	Begin at prebloom; repeat at bloom, petal fall, and in cover applications.	

* Resistant varieties now available are Prima, Priscilla, Sir Prize.

** No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
APPLE					
Fire blight	Bordeaux mixture	NTL**	0.5 lb Copper sulfate + 0.5 lb Lime/100 gal	Apply before first open blossoms and continue at 4-5-day intervals until petal fall.	May cause russetting in Golden Delicious apple.
	Streptomycin sulfate	50	0.85-1.7 oz/100 gal	Spray trees at 10% bloom; repeat at 3-5-day intervals until bloom is over.	Use 60 p/m spray/acre and 1,000 p/m dust in West Coast area. Use 60-100 p/m in other parts of country. Continual use may cause resistance.
Cedar-apple rust* (*Gymnosporangium juniperi-virginianae*)	Ferbam	7	0.76-1.52 lb/100 gal	Apply in prebloom, calyx, and early cover sprays.	Golden Delicious variety easily russetted by ferbam.
	Thiram	NTL**	0.98-1.3 lb/100 gal 1.7-2.6 lb/acre	Apply in prebloom, calyx, and cover sprays; keep foliage covered during infection periods.	
Quince rust* (*Gymnosporangium clavipes*)	Zineb	15-30	0.75-1.5 lb/100 gal 1.6-2 lb/acre	Apply in full schedule from delayed dormant to harvest.	
Powdery mildew (*Podosphaera leucotricha*)	Benomyl + Mancozeb	30	1-1.5 oz + 9.6 oz/100 gal; 1 qt spray oil may be added.	Apply at 1/2 in green tip and repeat at 7-14-day intervals (or as needed) through cover sprays.	Use the 1.5-oz rate of benomyl and add spray oil to spray mixture for varieties more susceptible to powdery mildew.
	Dinocap	21	1.5 oz/100 gal 5 oz/acre	Apply at 6-7-day intervals from tight cluster stage through petal fall, and 10-day to 2-week intervals through 4th cover.	
	Sulfur	NTL**	3.6-7.6 lb/100 gal 21-59 lb/acre	Apply from silver tip to cessation of growth.	Do not apply under conditions of extreme heat.
Sooty blotch (*Gloeodes pomigena*) and Fly speck (*Leptothyrium pomi*)	Benomyl + Mancozeb	30	1-1.5 oz + 9.6 oz/100 gal; 1 qt spray oil may be added.	Apply at 1/2 in green tip and repeat at 7-14-day intervals (or as needed) through cover sprays.	
	Captan + Zineb	15*** 30****	0.5 + 0.7 lb/100 gal 1.75 + 2.0 lb/acre	Apply in late cover periods.	Do not graze areas treated with zineb. Red Delicious and other sensitive varieties may be injured by early season applications of captan.

USE PESTICIDES SAFELY — READ THE LABEL

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* In orchards where NIA 9102, dinocap, or mancozeb is used as scab fungicide, no additional rust fungicide is required. ** No time limit.

*** For Arkansas, Delaware, Illinois, Indiana, Kansas, Kentucky, Maryland, Missouri, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia. **** For other States.

FRUIT DISEASES

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
APPLE					
Sooty blotch (*Gloeodes pomigena*) and Fly speck (*Leptothyrium pomi*) (con.)	Dinocap (4.7%) + Mancozeb (72.0%)	21	1.6 lb/100 gal 5.0 lb/acre	Apply in late cover periods.	Do not graze areas treated with dinocap + manzozeb.
	NIA 9102	15 or 30 depending on state	1.6 lb/100 gal 5.0 lb/acre		Do not graze areas treated with NIA 9102.
	Captan	NTL*	1.0 lb/100 gal 3.3 lb/acre		
	Folpet	NTL*	1.0 lb/100 gal 3.3 lb/acre	Begin at delayed dormant; repeat at 7-14-day intervals through cover spray. In Western States, do not apply between bloom and July 1.	Russetting may be caused on sensitive varieties in Eastern States when used from just before bloom to 30 days after petal fall.
Bitter rot (*Glomerella cingulata*)	Captan	NTL*	1.0 lb/100 gal 3.5 lb/acre	Apply in late cover and preharvest periods.	
	Ferbam	7	1.5-2.3 lb/100 gal	Apply in late cover sprays.	
	Folpet	NTL*	1.0 lb/100 gal 3.5 lb/acre	Begin at delayed dormant; repeat at 7-14-day intervals through cover sprays. In Western States, do not apply between bloom and July 1.	Russetting may be caused on sensitive varieties in Eastern States when used from just before bloom to 30 days after petal fall.
Blotch (*Phyllosticta solitaria*)	Ferbam	7	0.76-2.3 lb/100 gal	Apply in cover sprays.	Golden Delicious variety easily russetted by ferbam.
	Thiram	NTL*	0.98-1.3 lb/100 gal 1.7-2.6 lb/acre	Begin at prebloom; repeat at bloom and petal fall and in cover applications.	
	Zineb	15** 30***	0.75-1.5 lb/100 gal 1.6-2 lb/acre	Apply in full schedule from delayed dormant to harvest.	
Brooks' spot (*Mycosphaerella pomi*)	Captan	NTL*	0.25-1 lb/100 gal 1.1-3.75 lb/acre	Apply in cover periods.	
	Ferbam	7	0.76-1.52 lb/100 gal	Apply in cover sprays.	
	Folpet	NTL*	0.75-1 lb/100 gal	Begin at delayed dormant; repeat at 7-14-day intervals through cover sprays. In Western States, do not apply between bloom and July 1.	Russetting may be caused on sensitive varieties in Eastern States when used from just before bloom to 30 days after petal fall.
Black pox (*Helminthosporium papulosum*)	Captan	NTL*	1 lb/100 gal 2-3.75 lb/acre	Apply in late cover and preharvest periods.	

* No time limit. ** For Arkansas, Delaware, Illinois, Indiana, Kansas, Kentucky, Maryland, Missouri, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia. *** For other States.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
APPLE					
Bullseye rot or Perennial canker (*Neofabraea perennans*)	Captan	NTL*	1 lb/100 gal 8 lb/acre	Apply in first and second cover sprays or in 1 or 2 preharvest sprays, or as needed at 5-7-day intervals from prebloom to early cover periods.	
	Ziram	7	0.75-1.125 lb/100 gal 7.5 lb/acre	Apply preharvest, before fall rains; repeat if necessary, especially if excessive rainfall occurs.	Pacific Northwest only.
APRICOT					
Brown rot (*Monilinia fructicola* and *M. laxa*)	Captan	NTL*	1 lb/100 gal 5 lb/acre	Apply in red bud, bloom, 75% petal fall, and cover periods.	Should not be used with or closely following oil sprays.
	Maneb	14	1.2-1.6 lb/100 gal	Begin at red bud stage; repeat in early bloom, full bloom, petal fall, and at 7-14-day intervals as necessary up to 2 weeks before harvest.	
Shothole (*Coryneum beijerinckii*)	Bordeaux mixture	NTL*	10 lb Copper sulfate + 10 lb Lime/100 gal	Dormant application.	
	Ferbam	21	0.76-1.14 lb/100 gal	Apply after harvest; repeat in spring when buds swell and at shuck shed.	West Coast only.
	Ziram	Do not apply after early cover sprays.	1.14-1.52 lb/100 gal	Apply at red bud, early bloom, and full bloom, or under severe conditions repeat at 5-day intervals until full bloom.	
BLACKBERRY					
Anthracnose (*Elsinoe veneta*)	Lime-sulfur	NTL*	10 gal 29-31% a.i. solution/100 gal	Apply spray in late winter or early spring when new growth is less than 1/2 in long.	
	Bordeaux mixture	NTL*	8 lb Copper sulfate + 8 lb Lime/100 gal		
	Captan	NTL*	1 lb/100 gal 2 lb/acre	Apply spray just before blossoms open, when new growth canes are about 1 ft long, and just after harvest.	For use east of the Rocky Mountains.
	Ferbam	40	1.5 lb/100 gal 5.7 lb/acre		

* No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
BLACKBERRY					
Fruit rots (*Monilinia fructicola* and *Botrytis cinerea*)	Captan	NTL*	1.0 lb/100 gal	Apply spray during the period of fruit ripening and harvest.	
BLUEBERRY					
Blossom blight (*Botrytis cinerea*), Mummy berry (*Monilinia vaccinii corymbosi*), and Leaf spots (*Phyllostictina vaccinii*, *Dothichiza caroliniana*, and *Gloeocercospora inconspicua*)	Benomyl + Captan	21	0.25 lb + 1 lb/100 gal	Begin at midbloom; repeat at 7-10-day intervals until maturity.	
	Captan	NTL*	1 lb/100 gal		
	Captafol	21	2 lb flowable liquid/100 gal		
CHERRY					
Brown rot (*Monilinia fructicola*)	Bordeaux mixture	NTL*	10 lb Copper sulfate + 10 lb Lime/100 gal	Apply in popcorn and petal fall.	Do not apply to sweet cherries after petal fall.
	Benomyl + Captan	21 NTL*	0.25 lb + 0.5 lb/100 gal	Apply immediately before blossoms open, in full bloom, and at 7-10-day intervals thereafter.	Do not graze livestock in treated areas.
	Captan	NTL*	1 lb/100 gal	For blossom blight, apply at 3-4-day intervals during bloom.	
			1-2 lb/100 gal 1.1-5 lb/acre	For fruit rot, apply in pink, full bloom, petal fall, shuck shed, and cover periods.	
	Dichlone	3	0.25 lb/100 gal 1.25 lb/acre	For twig brown rot, begin at pink bud; repeat at full bloom and before shuck shed, or every 4 days in cool, wet weather.	
				For blossom blight, apply at popcorn, full bloom, and petal fall.	
				For fruit rot, apply at 7-10-day intervals from petal fall to 3 days before harvest.	
	Folpet	NTL*	1 lb/100 gal 4.5-6.0 lb/acre	Begin when 10% of blossoms open; continue at 10-14-day intervals until fruit begins to color well.	Folpet should be used on sour cherries only.
	Ziram	7	1.14 lb/100 gal 2.8-4.0 lb/acre	Begin when first blooms open; repeat at full bloom and as necessary in cover sprays.	

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* No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CHERRY					
Leaf spot (*Coccomyces hiemalis*)	Captan	NTL*	1-2 lb/100 gal 3-4 lb/acre	Apply in pink, bloom, petal fall, and first cover periods, and in 2 postharvest sprays.	
	Folpet	NTL*	1 lb/100 gal 4.5-6.0 lb/acre	Apply in cover period at 7-14-day intervals until fruit begins to color well; repeat once or twice in postharvest period.	Folpet should be used on sour cherries only.
	Glyodin	7	1.5-2 pt of 30% solution/ 100 gal	Begin at petal fall; repeat at shuck shed, in first and second preharvest sprays, and as a postharvest foliar spray.	Glyodin should be used on sour cherries only.
Powdery mildew (*Podosphaera oxyacantha*)	Benomyl	21	1/4 lb/100 gal 0.6 lb/acre	Apply spray at petal fall, shuck shed, and first cover; repeat at 7-10-day intervals if necessary.	
	Sulfur	NTL*	1.5-3 lb/100 gal		
Botrytis rot (*Botrytis cinerea*)	Benomyl	21	1/4 lb/100 gal	Apply at petal fall, at shuck shed, and in cover sprays.	
	Captan	NTL*	1-2 lb/100 gal 6 lb/acre		
CITRUS					
Anthracnose (*Gloeosporium limetticola* and *Colletotrichum gloeosporioides*)	Ferbam	NTL*	1.14-2 lb/100 gal	Apply in prebloom period, at two-thirds petal fall, and in late summer or early fall if heavy flush of growth occurs.	
Greasy spot (*Cercospora* sp.)	Benomyl	NTL*	0.75-1.5 lb/acre	Make a single application from mid-June to mid-July.	
	Zineb	NTL*	0.75-1.0 lb/100 gal 1.6-2 lb/acre	Begin when young fruit is 1/2 inch in diameter; repeat as needed.	
Brown rot (*Phytophthora citrophthora*)	Bordeaux mixture	NTL*	6 lb Copper sulfate + 6 lb Lime/100 gal	Spray ground under trees and the lower branches up to 3 ft above the ground just before first rains or as soon thereafter as possible.	

* No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CRANBERRY					
Fruit rots	Captafol	50	1-1.5 lb F/100 gal	Apply at midbloom and 10-14 days later.	
	Ferbam	Do not apply later than 28 days after midbloom.	1.5 lb/100 gal	Begin at midbloom; repeat once or twice at 2-week-intervals.	
	Folpet	30	4.5 lb/acre in enough water to cover.	Begin at bloom; repeat at 10-14-day intervals.	
	Maneb	30	1.6-2.4 lb/100 gal 3-6 lb/acre	For Massachusetts, begin at midbloom; repeat 3 times at 10-14-day intervals.	
			1.6 lb/100 gal	For New Jersey and Wisconsin, begin after midbloom; repeat 10-14 days later, 4 weeks after midbloom, and 2-3 weeks later.	
	Zineb	Do not apply after midbloom.	1.5-2.25 lb/100 gal 1.5-3 lb/acre	Apply at 5% bloom; repeat at midbloom.	
Twig blight (*Lophodermium* sp.)	Captan	NTL*	1 lb/100 gal	Begin about July 19; repeat in early and in late August.	
	Maneb	30	1.6 lb/100 gal	For Washington and Oregon, begin after blooming; repeat between July 10-20, August 1-10, and August 10-25.	
CURRANT AND GOOSEBERRY					
Fruit rot (*Botrytis cinerea*)	Ferbam	14	0.76-1.5 lb/100 gal 1.7-2.9 lb/acre	Begin in prebloom stage; repeat at postbloom, 2 weeks later, and after harvest.	
Leaf spot (*Mycosphaerella ribis*)	Bordeaux mixture	NTL*	3 lb Copper sulfate + 3 lb Lime/100 gal	Apply 2-3 weeks after bloom, or about the time the first few lower leaves in center of bushes show signs of lesions or spots. Subsequent sprays, generally in postharvest period, will prevent secondary spread of disease.	
	Ferbam	14	0.76-1.5 lb/100 gal 1.7-2.9 lb/acre	Begin at prebloom stage; repeat at postbloom, 2 weeks later, and after harvest.	

* No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
GRAPE					
Black rot (*Guignardia bidwellii*)	Benomyl	7	0.5 lb/acre	Apply just before blossoms open, immediately after bloom, and then at 10-14-day intervals.	East of Rockies.
	Captan	NTL*	1 lb/100 gal 1.1-2.1 lb/acre	Make 2 applications before blossoming and 3 or 4 applications at 10-15-day intervals after bloom.	
	Ferbam	7	0.76-1.52 lb/100 gal 1.7-2.9 lb/acre	Apply just before bloom, just after bloom, and 2 weeks before berries touch.	
	Maneb	7	1.6 lb/100 gal		
	Zineb	7	1.5 lb/100 gal	Apply just before bloom, just after bloom, 10 days after bloom, and 2 to 3 weeks later. Cover thoroughly.	
Cane and leaf spot (Formerly, Dead arm) (*Phomopsis viticola*)	Captan	NTL*	1-2 lb/100 gal	In Northeastern States, begin when new shoots average 1 in long and repeat when shoots average 5 in long. In California, begin from budbreak to when shoots average 1/2 in long; repeat when shoots are 5-6 in long.	
	Folpet	NTL*	1 lb/100 gal		
Downy mildew (*Plasmopara viticola*)	Bordeaux mixture	NTL*	6 lb Copper sulfate + 6 lb Lime/100 gal	Begin when new growth is 1/2 in long; repeat at 2-week intervals.	
	Captan	NTL*	1 lb/100 gal 1.1-2.1 lb/acre	Make 2 applications before blossoming and 3 or 4 applications at 10-15-day intervals after bloom.	
	Folpet	NTL*	1 lb/100 gal	Apply 250-300 gal per acre. Begin just before bloom; repeat just after bloom, and at 7-10-day intervals for 1-3 more applications.	During periods of extended hot, dry weather, foliage injury may occur.
	Zineb	7	1.5 lb/100 gal	Apply just before bloom, just after bloom, 10 days after bloom, and 2 to 3 weeks later. Cover thoroughly.	

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* No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
GRAPE					
Powdery mildew (*Uncinula necator*)	Dinocap	21	0.5 lb/acre	On varieties susceptible to powdery mildew and tolerant of sulfur, 2-3 sprays before flowering and one after will generally control powdery mildew throughout the season.	
	Sulfur (wettable)	NTL*	4-6 lb/100 gal 5-10 lb/acre	Programs for black rot and downy mildew using bordeaux mixture, captan, zineb, or folpet usually control powdery mildew.	During periods of hot weather, foliage injury may occur.
Bitter rot (*Melanconium fuligineum*)	(See Safety Restrictions and Remarks.)			In vineyards where bitter rot is severe, apply bordeaux mixture (4-4-100) a month before harvest and a spray of captan or zineb 2 weeks later.	If spray schedule for control of black rot is followed, this disease usually does not become a problem.
Anthracnose or Bird's eye rot (*Elsinoe ampelina*)	Lime-sulfur	NTL*	2 qt of 26-31% suspension/100 gal	Apply during dormant season, then 4 or 5 applications of bordeaux mixture (4-4-100) or ferbam (1.5 lb/100 gal or 2.9 lb/acre) in growing season.	
NECTARINE					
Brown rot (*Monilinia fructicola* and *M. laxa*)	Benomyl + Captan	NTL* NTL*	1/8-1/4 lb + 1 lb/100 gal or 1/4-1/2 + 2 lb/acre	Apply in pink, petal fall, and cover periods.	
	Captan	NTL*	1 lb/100 gal 5 lb/acre	Same as above.	
	Maneb	14	1.6 lb/100 gal	Begin at red bud; repeat in early bloom, full bloom, and petal fall, and at 7-14-day intervals up to 2 weeks before harvest.	
	Sulfur (wettable)	NTL*	3.75-9.7 lb/100 gal 12.5-60 lb/acre	Apply in pink bud, full bloom, and covers as long as necessary.	*Monilinia laxa* is important mainly on the West Coast. Do not spray during hot weather because injury may occur.
Scab (*Cladosporium carpophilum*)	Captan	NTL*	1 lb/100 gal 2.5-5 lb/acre	Apply in pink, petal fall, and cover periods.	
	Sulfur (wettable)	NTL*	4-6 lb/100 gal 15 lb/acre		

* No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
NECTARINE					
Powdery mildew (*Podosphaera oxyacanthae* and *Sphaerotheca pannosa*)	Sulfur (wettable)	NTL*	3.75-9.7 lb/100 gal 12.5-60 lb/acre	Apply in pink, bloom, and early petal fall, 2 weeks later, and in beginning of pit hardening.	Do not spray during or just before hot weather because injury may occur.
Leaf curl (*Taphrina deformans*)	Bordeaux mixture	NTL*	10 lb Copper sulfate + 10 lb Lime/100 gal	Dormant to popcorn stages.	
Coryneum blight - shot hole (*Coryneum beijerinckii*)	Bordeaux mixture	NTL*	10 lb Copper sulfate + 10 lb Lime/100 gal	Late fall application.	
	Captan	NTL*	1 lb/100 gal 5 lb/acre	Apply in pink bud, petal fall, and cover periods, and in late fall.	
	Maneb	14	1.6 lb/100 gal	Begin at red bud; repeat in early bloom, full bloom, and petal fall, and at 7-14-day intervals up to 2 weeks before harvest.	
	Zineb	40	1.125 lb/100 ga 1.6-2 lb/acre	Apply in postharvest or dormant periods and in popcorn to petal fall.	

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* No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PEACH					
Brown rot (*Monilinia fructicola*)	Benomyl + Captan	NTL* NTL*	0.125-0.25 lb + 1-2 lb/100 gal or 0.25-0.50 lb + 2.25 lb/acre	Apply in pink, full bloom, shuck shed, cover, and preharvest periods. For blossom blight, apply at 3-4-day intervals during bloom.	
	Captan	NTL*	1-2 lb/100 gal		
	Dichlone	7	0.25 lb/100 gal	Apply at pink bud, full bloom, and just before shuck shed. For fruit rot, use same dosages in preharvest spray.	
	Lime-sulfur	NTL*	2 qt of 27.5-31% solution/8-16 gal	Apply 3-5 times at weekly intervals before harvest.	May cause "sunburn" if applied when temperature is above 85°F.
			1 pt of 29-31% solution/8-16 gal	For blossom blight, apply in prebloom, early bloom, and full bloom stages.	
	Maneb	2	1.6 lb/100 gal	Begin at red bud; repeat in early bloom, full bloom, and petal fall and at 7-14-day intervals up to 2 weeks before harvest.	If applied within 14 days of harvest, remove residues by brushing.
	Thiram	7	0.98-1.3 lb/100 gal 1.96 lb/acre	Begin at pink stage; repeat at 3-4-day intervals during bloom for blossom blight, and at petal fall and cover applications for fruit rot.	
	Sulfur (wettable)	NTL*	3.75-9.7 lb/100 gal 12.5-60 lb/acre	Apply in pink, bloom, petal fall, shuck split, and shuck shed stages, and at 10-14-day intervals as long as necessary. For brown rot of fruit, apply when fruit begins to ripen.	
Scab (*Cladosporium carpophilum*)	Captan	NTL*	1 lb/100 gal 5 lb/acre	Apply in pink, full bloom, shuck shed, cover, and preharvest periods.	
	Sulfur (wettable)	NTL*	3.75-9.7 lb dry material in 3 sprays/100 gal 12.5-60 lb/acre	First application in shuck shed period and the other two at 10-day intervals.	If disease is very severe, four sprays may be necessary.

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* No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PEACH					
Powdery mildew (*Podosphaera oxyacanthae* and *Sphaerotheca pannosa*)	Dinocap	45	1-2 oz/100 gal	Apply at shuck shed; repeat as needed throughout the season.	
	Sulfur (wettable)	NTL*	3.75-9.7 lb/100 gal 12.5-60 lb/acre	Apply in shuck shed through third cover.	
Bacterial spot** (*Xanthomonas pruni*)	Dodine + Captan	15	0.325 lb dodine + 0.5 lb captan/100 gal	Begin at shuck split; repeat at 7-10-day intervals in cover period, more frequently during wet weather.	Bacterial spot control with this combination is effective under only light to moderate disease conditions. Do not combine dodine and captan with solvent formulations of insecticides or sulfur.
	Zinc sulfate	NTL*	1.6 lb/100 gal	Apply at petal fall and shuck split or according to state agricultural authorities.	
Leaf curl (*Taphrina deformans*)	Bordeaux mixture	NTL*	20-24 lb of prepared WP/100 gal or 10 lb Copper sulfate + 10 lb Lime/100 gal	In fall or spring before buds swell.	Never apply copper sprays to peach trees during growing season.
	Dichlone	7	0.5 lb/100 gal	In dormant period just before buds begin to swell.	
	Ferbam	21	2.3 lb/100 gal	In Western States, in fall after leaves drop; repeat in dormant early spring period.	
	Lime-sulfur	NTL*	10-12 gal of 26-31% solution/100 gal spray.	In fall or spring before buds swell.	
	Ziram	NTL*	1.125-2.25 lb/100 gal 3-4 lb/acre	In dormant and popcorn stage. For West Coast, apply just before fall rains or in November and repeat in 3 months while trees are still dormant and again in popcorn stage.	

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* No time limit.

** Peach varieties with a high degree of resistance to bacterial spot are available and should be planted whenever possible.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PEACH Coryneum blight (*Coryneum beijerinckii*)	Bordeaux mixture	NTL*	10 lb Copper sulfate + 10 lb Lime/100 gal	Apply only during and after leaf fall.	Never apply copper sprays to peach trees during growing season.
	Captan	NTL*	1 lb/100 gal	Apply in pink bud, full bloom, petal fall, and cover periods.	Western States.
	Dichlone	7	1.87 lb/acre	Apply between September 15-30 in Oregon and Washington.	
	Ferbam	21	0.76-1.14 lb/100 gal	Apply in fall before leaves drop; repeat in dormant early spring period.	
	Ziram	NTL*	1.25-2.25 lb/100 gal 3-4 lb/acre	Apply after leaf fall and again in popcorn stage.	
PEAR Scab (*Venturia pirina*)	Captan	NTL*	1 lb/100 gal 2-3 lb/acre	Primary infection: Apply in pink, petal fall, and first two cover periods.	Do not use on d'Anjou pears. Russetting may be produced on Bosc pears.
			1 lb/100 gal	Secondary infection: Apply in cover periods.	
	Dodine	7	0.49 lb/100 gal 0.8-1.2 lb/acre	Begin in prebloom stages; repeat at 5-7-day intervals through first cover spray.	Do not graze cover crops in treated orchards. Western States only.
			0.325-0.49 lb/100 gal	Use in subsequent sprays.	
	Ferbam	7	0.7-1.52 lb/100 gal 1.9-3.0 lb/acre	Apply in pink and calyx stages and through second cover.	
	Glyodin	NTL*	0.525 lb/100 gal	Begin at delayed dormant stage; repeat at prepink, pink, bloom, and petal fall stages, and in cover sprays.	
	Zineb	7	1.12 lb/100 gal	Apply at prebloom, petal fall, and in cover sprays.	

* No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PEAR					
Fire blight (*Erwinia amylovora*)	Bordeaux mixture	NTL*	1 lb of 12.5% copper in dry mix formulation/100 gal	Apply when first blooms start to open and through third cover.	May cause russetting of fruit.
	Streptomycin sulfate	30-50	0.85-1.7 oz/100 gal	Spray trees at 10% bloom; repeat at 3-5-day intervals until bloom is over. To control twig blight, continue sprays at 5-14-day intervals or 1,500 p/m (40 lb) of 0.15% dust per acre.	60 p/m spray at 600 gal per acre and 1,500 p/m dust for use in West Coast area only. 50-100 p/m at 600 gal per acre suggested for use in other parts of the country.
	Zineb	7	1.5 lb/100 gal	Apply at 10% bloom, full bloom, and petal fall, or at 2-3-day intervals during blooming.	
Powdery mildew (*Podosphaera leucotricha*)	Dinocap	21	0.19-0.25 lb as WP or 1.9-2.9 oz as LC /100 gal 0.4-0.5 lb D/acre	Apply at delayed dormant stage; repeat at 7-14-day intervals as necessary.	
	Sulfur (wettable)	NTL*	3.8-7.6 lb/100 gal 8-60 lb/acre	Apply as prebloom and early postbloom sprays.	Do not apply when temperature is above 85°F.
Sooty blotch (*Gloeodes pomigena*) and Fly speck (*Leptothyrium pomi*)	Captan	NTL*	0.5-1.0 lb/100 gal	Begin at petal fall and apply in cover sprays.	
	Ferbam	7	0.76-1.14 lb/100 gal 1.9-3 lb/acre	Apply as cover sprays.	
	Zineb	7	0.75-1.125 lb/100 gal	Apply as cover sprays.	
Bull's-eye rot or Perennial canker (*Neofabraea perennans*)	Ziram	7	0.75-1.125 lb/100 gal 3.5-7.5 lb/acre	Apply in prebloom, bloom, and cover sprays.	
Leaf blight (*Fabraea maculata*)	Ferbam	7	0.76-1.14 lb/100 gal 1.9-3 lb/acre	Apply as cover sprays.	
	Zineb	7	0.75-1.125 lb/100 gal	Apply as cover sprays.	

* No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PLUM AND PRUNE					
Leaf spot (*Coccomyces* spp.)	Ferbam	7	0.76-1.14 lb/100 gal	Apply in fall after harvest and before leaf drop; repeat in spring as buds swell.	
Brown rot (*Monilinia fructicola*)	Benomyl + Captan	NTL* NTL*	0.125-0.25 lb + 0.75-1 lb/100 gal	Apply at red bud, 75% bloom, petal fall, and in covers as necessary. Use no more than 1 lb a.i. benomyl/acre.	
	Captan	NTL*	1 lb/100 gal		
QUINCE					
Rust (*Gymnosporangium clavipes*)	Captan + Zineb + Sulfur	40	2.1 lb + 2.1 lb + 12.5 lb/acre	Apply at prebloom and petal fall; repeat at 10-14-day intervals.	
Leaf blight (*Fabraea maculata*)	Ferbam	7	0.76-1.14 lb/100 gal	Apply in pink and petal fall stages, and in cover sprays.	
Bitter rot (*Glomerella cingulata*)	Captan + Zineb + Sulfur	40	2.1 lb + 2.1 lb + 12.5 lb/acre	Apply in prebloom period; repeat at petal fall and at 10-14-day intervals.	
Brown rot (*Monilinia fructicola*)	Captan + Zineb + Sulfur	40	2.1 lb + 2.1 lb + 12.5 lb/acre	Begin when disease threatens; repeat at 7-10-day intervals.	
Scab (*Venturia pirina*)	Captan	7	1.0-1.7 lb/100 gal 5 lb/acre	Begin when disease threatens; repeat at 7-10-day intervals.	

* No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
STRAWBERRY Leaf spots (*Mycosphaerella fragariae*) and Leaf scorch (*Diplocarpon earliana*)	Benomyl	NTL*	0.25-0.5 lb/acre	Apply when growth starts in spring and continue in cover sprays until berries are one-third grown.	Tolerant strains of fungi may develop when benomyl is used exclusively in a spray schedule; therefore, alternate benomyl sprays with sprays of other fungicides.
	Bordeaux mixture	NTL*	12-14 lb of 12.75% copper formulation /100 gal or 8 lb Copper sulfate + 8 lb Lime/100 gal	Apply when new growth starts in spring; maintain protective cover sprays to harvest.	In moist, coastal area spray in summer with bordeaux mixture 6-6-100 and maintain protective cover spray on plants until berries are one-third grown. Apply final bordeaux mixture at 8-8-100 before fall rains when the disease has been troublesome.
	Captan	NTL*	1.5 lb/100 gal 3 lb/acre	Begin at new growth stage; repeat at 7-day intervals through picking.	
	Dodine	14	1-1.3 lb/200-300 gal/acre 1-1.3 lb/acre	Begin when new growth starts; repeat at weekly intervals.	
Fruit rots (*Botrytis cinerea*, *Pezizella lythri*, *Rhizoctonia* sp., *Phytophthora cactorum*, *Mycosphaerella fragariae*, and *Gnomonia fructicola*)	Benomyl	NTL*	0.25-0.5 lb/acre	Apply spray at 7-10-day intervals from the time new growth starts up until harvest.	Tolerant strains of fungi may develop when benomyl is used exclusively in a spray schedule; therefore, alternate benomyl sprays with sprays of other fungicides.
	Captan	NTL*	1.5 lb/100 gal 3 lb/acre	Begin at new growth; repeat at 7-10-day intervals through picking.	
	Thiram	3	1.3-1.63 lb/100 gal 1.75-2.6 lb/acre	Begin at early blossom stage; repeat at 10-day intervals as necessary.	Remove residues by washing if applications are made within 3 days of picking.
	Zineb	7	1.125-1.5 lb/100 gal 0.8-2.4 lb/acre	Begin when new growth starts; repeat at 10-day intervals.	
Powdery mildew (*Sphaerotheca macularis*)	Sulfur (wettable)	(See Safety Restrictions and Remarks)	1.8-4.9 lb/100 gal 3-50 lb/acre	Begin with first sign of disease; repeat as necessary.	Discontinue sulfur applications well before harvest. May injure strawberries under certain climatic conditions.

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* No time limit.

FRUIT AND VEGETABLE POSTHARVEST DISEASES

by

Harold E. Moline

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ALTERNATIVE CONTROL MEASURES

The following nonchemical methods of control are available for use against postharvest pathogens.

Sanitation

Many postharvest pathogens of fruits and vegetables can survive for prolonged periods growing as saprophytes on soil surfaces, wood, and other debris. By removing such sources of inoculum in packinghouses and storage facilities, decay may be reduced dramatically. Steam cleaning has proved an effective method of killing spores and cleaning surfaces. By removing sources of inoculum, contamination of produce on packing lines can be minimized.

Dump tanks are another source of contamination that can accumulate much trash and become a ready source of inoculum for otherwise healthy produce. Fungicides and disinfectants, such as sodium hypochlorite, have been added to wash water to reduce chances for contamination. The results have been less than dramatic. Recently, use of warm water in tomato dump tanks has been shown as effective in reducing bacterial soft rots as chemical treatments. Cold water, that is, water at a temperature lower than the fruit, is absorbed readily by the fruit, carrying with it bacteria that produce soft rots. Warm water, conversely, is not taken up by the fruit, and decay is reduced dramatically.

Hot Water Treatment

Hot water treatments have proved effective in reducing postharvest decays of stone fruits. Hot water can replace fungicide treatments or it can be used as a supplement to fungicide treatments if produce is to be stored for prolonged intervals after treatment. Temperatures in the range of 115-125°F (46-52°C) have been used to sanitize fruit. Dips of 2 1/2 minutes have proved most effective. If hot water treatment is used in conjunction with fungicides, application rates of the fungicides can be reduced up to 90 percent and efficacy can be maintained.

High Humidity Storage

Very high humidity storage (above 95-98 pct+) has proved effective in reducing decay and maintaining quality of carrots and other root crops. The Canadians routinely use jacketed storage facilities to store carrots for prolonged periods. These facilities are designed to minimize temperature fluctuations that would allow water condensation to become a problem; even in the presence of free water (condensation), however, decay and weight loss can be reduced substantially by storing produce at high humidity.

Controlled Atmosphere Storage

Modifying the storage atmosphere can effectively maintain produce quality and reduce deterioration; to ensure maximum quality of stored products, however, fungicide treatment should be used before placing produce in controlled-atmosphere storage. Controlled atmosphere is used widely to store apples and has been tested on other fruits. Cabbage also is stored under controlled atmosphere for 8 to 10 months in some areas. High concentrations of carbon dioxide (up to 30 pct) also have been used for short periods to prolong storage life of selected fruits and vegetables. Low-pressure storage (hypobaric) also has been used to extend storage life of produce, but the cost of this treatment has made it prohibitive for all but highly perishable, high-cost items.

All types of produce do not react favorably to controlled atmospheric, high carbon dioxide, or hypobaric treatments; cost in relation to return also must be considered carefully.

Cold Storage

The growth of many postharvest pathogens can be stopped or greatly reduced at low temperatures; however, not all produce can be stored at low temperatures without deteriorating. For the proper temperature requirements, the reader should consult Agriculture Handbook 66, "The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks," which lists storage temperature requirements for most fruits and vegetables. If used properly, cold storage can be a nonchemical means of reducing decay. It can also be used as a supplement to chemical treatment for the control of postharvest pathogens

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
APPLE					
Blue mold (*Penicillium expansum*), Gray mold, (*Botrytis cinerea*), and Anthracnose (*Gloeosporium* spp.)	Benomyl		WP, 4 oz/100 gal	Postharvest dip.	
	OPP + Thiabendazole (2:1)		0.6% ready-to-use liquid wax	Postharvest spray.	
	SOPP		0.3-1.45% solutions	Postharvest dip, wash, foam or spray.	Fruit usually rinsed after treatment to avoid injury. For blue mold and gray mold.
	Thiabendazole		WP, 40-60% active; use 0.9 lb/100 gal	Apply as a dip or spray.	Do not treat more than 3 minutes. For blue mold and gray mold.
Storage scald (physiological)	Diphenylamine				General limitations: Do not use treated apples for pomace for livestock feed or graze cover crops in treated orchards, as illegal residues may occur in meat or milk. Only treat apples once with diphenylamine. Diphenylamine may cause injury to some fruit; see label for details.
			2,000 p/m	Dip or spray.	Within 7 days of harvest.
			5,000 p/m	In wax emulsion.	Within 7 days of harvest.
			0.095-0.10%	In paper wraps.	Within 7 days of harvest.
			WP, 0.83-1.66 lb/ 100 gal; LC, 1,000-2,000 p/m	Preharvest spray 36 hr before harvest.	Do not use postharvest treatment.
	Ethoxyquin		2,650 p/m	Use a line spray system.	Apply within week of harvest.
			400 p/m	Paper wraps.	Apply within week of harvest.
			2.25 lb/100 gal	Apply as spray.	Spray 1 or 2 days before harvest.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
APRICOTS					
Botrytis rot (*Botrytis cinerea*), Rhizopus rot (*Rhizopus stolonifer*), and *Gloeosporium* spp.	Captan		1.0-1.2 lb/100 gal water	Spray or dip.	
Postharvest fruit rots	Benomyl		WP, 4 oz/100 gal water or incorporated into wax spray	Dip or spray as soon as possible after harvest.	
BANANAS					
Crown rot (*Botryodiplodia theobromae*) and other fungi	Benomyl		0.25-0.5 lb/100 gal	Dip or spray.	Keep suspension stirred.
Crown rot - surface mold (*Colletotrichum musae*) and other fungi	Thiabendazole		2.67 oz WP/100 gal (200 p/m); 1 gal of 5% LC/250 gal (200 p/m); or 0.71-1.62 oz flowable/60 gal	Dip fruit after it has been dehanded and passed through delatexing operation.	Keep suspension stirred.
CANTALOUPS					
Postharvest decay organisms	Captan		1.0-1.2 lb/100 gal water	Spray or dip.	
	Sodium dimethyldithiocarbamate		1.0 gal of 40% LC/35 gal of approved wax emulsion/50 crates fruit	Spray.	
	SOPP		1.1-1.5% solutions	Spray or dip.	Do not rinse.
	Tetraiodoethylene		1,000-2,500 p/m	Apply with wax.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CARROT, CELERY, PEPPER, POTATO, AND TOMATO					
Bacterial soft rot (Erwinia carotovora)	Calcium hypochlorite		25 p/m available chlorine	Postharvest dip for 2 minutes.	For potatoes, spray 1 gal of solution containing 500 p/m available chlorine over each ton of unwashed tubers entering storage on a conveyor line. Provide tumbling action during treatment.
	Sodium hypochlorite		55-70 p/m available chlorine	Postharvest dip.	Rinse with fresh tap water.
CARROT					
Cottony rot (Sclerotinia sclerotiorum)	DCNA		0.75 lb (1,350 p/m suspension)/100 gal	Dip harvested roots for 10 seconds in well-agitated suspension. Do not rinse after treatment.	
	SOPP		0.73% solutions	Dip or spray.	
CHERRY					
Blue mold (Penicillium spp.), Brown rot (Monilinia fructicola), and Rhizopus rot (Rhizopus stolonifer)	Benomyl		0.25 lb/100 gal	Dip or spray.	Immediately after harvest. Will not control Rhizopus rot.
	Captan		1.0-1.2 lb/100 gal water	Dip or spray.	
	SOPP		0.75% solutions	Flood or spray.	Rinse to avoid injury.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CHERRY (SWEET) Rhizopus rot (*Rhizopus stolonifer*)	Captan		1.0-1.2 lb/100 gal water	Spray or dip.	Do not reclaim spray.
	DCNA		WP, 1 lb/100 gal or 1 gal 9.0% liquid formulation in 75 gal water (1,200 p/m)	As spray when sorting.	
CITRUS (Arizona-California) (Grapefruit, oranges, and lemons) Penicillium blue and green molds (*Penicillium italicum* and *P. digitatum*)	Benomyl		0.5-1.0 lb/100 gal water or wax; 0.2 lb/100 gal water on sporulating *Penicillium*	In packinghouse.	
	Biphenyl		4 lb biphenyl per 1,000 sq ft impregnated in pads containing 25% biphenyl, 50% paraffin, and 24% mineral oil	Apply 2 pads 10-9/16" x 16-1/4" containing 2.5 g biphenyl to each 4/5 bu carton. One pad near top and other on bottom.	
	Borax		4% solution at 110°F	At harvest.	Wash in foam detergent and rinse in potable water after storage and before packing and shipping.
	sec-Butylamine		2% aqueous	Drench picking boxes, bins, and pallet boxes.	Do not rinse after treatment.
			2% aqueous	As spray when sorting.	Do not rinse after treatment.
	Captan		1.0-1.2 lb/100 gal water	Spray or dip.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CITRUS (Arizona-California) (Grapefruit, oranges, and lemons) Penicillium blue and green molds (Penicillium italicum and P. digitatum) (con.)	Methylene chloride		2 qt product (2.7 lb)/1,000 cu ft - 24 hr	During degreening.	
	OPP		8,000 p/m in approved wax	At harvest.	
	SOPP		WP, 0.5% in water	In wash maintained at pH 11.8-12.0. Soak 1-3 min.	Rinse to avoid injury. Do not use on lemons.
			1% wax emulsion; 1 gal/10,000 lb of fruit	Use 0.8-1% SOPP in shipping wax. Apply before shipping and buff with soft brushes.	Do not use on lemons going into storage because of possible resistant strains.
			1.5% foam	At harvest and sometimes to lemons on removal from storage.	
Penicillium blue and green molds (Penicillium italicum and P. digitatum), Brown rot (Phytophthora sp.), and Stem-end rot (Phomopsis-Diplodia sp.)	Bordeaux mixture		3 lb Copper sulfate 3 lb Lime/100 gal water	Apply to trees before and during rainy period as spray to lower trunks, leaves, or fruit.	The copper in bordeaux mixture may cause tree injury.
	Thiabendazole		4.18 lb WP/100 gal water	Spray or flood at harvest.	
(Lemons) Black rot (Alternaria citri)	2,4-D		Isopropyl ester 200-500 p/m in water or wax emulsion	Usually applied when fruit is stored.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CITRUS (Florida) (Grapefruit, limes, oranges, tangerines, tangelos, citron, and kumquat) Stem-end rot (*Phomopsis citri* or *Diplodia natalensis*), Penicillium blue and green molds (*Penicillium italicum* and *P. digitatum*), black rot (*Alternaria citri*), Anthracnose (*Colletotrichum gloeosporioides*), and other decays	Benomyl	See "CITRUS (Arizona-California)"			
	Biphenyl		Impregnated pads 11" x 17" each containing 2.35 g	Apply 2 pads per 4/5 bu at packing.	
	sec-Butylamine	See "CITRUS (Arizona-California)"			
	2,4-D	See "CITRUS (Arizona-California)"			
	SOPP		1% in water-wax emulsion	Dip, flood, or spray before packing.	Maintain pH between 11.8-12.0 to avoid toxicity.
	Thiabendazole	See "CITRUS (Arizona-California)"			
CRANBERRIES Postharvest decays	Captan		1.0 lb/100 gal water	Apply as spray during first week of June, late August, and 2 weeks later.	West of the Rocky Mountains.
CUCUMBER Postharvest decay during shipment and sales	Captan		1.25 lb/100 gal spray or dip	Apply immediately after harvest; wet all surfaces.	
	OPP		10,000-25,000 p/m in approved wax		
	SOPP		0.73% solution	Dip, flood, or spray to wet all surfaces thoroughly. Rinse for at least 30 seconds with potable water.	
			1.5% wax emulsion	Dip, flood, or spray.	Do not rinse.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
GRAPE					
Gray mold (*Botrytis cinerea*)	Captan		1.2 lb/100 gal water	Apply as spray or dip.	
MANGOS					
Postharvest decays	Captan		1.0-1.2 lb/100 gal water	Spray or dip.	
ONIONS					
Postharvest molds and storage rots	Captan		1.25 lb/100 gal water	Spray or dip washed and rinsed onions before drying and storage.	
PEACHES, PLUMS, and NECTARINES					
Brown rot (*Monilinia fructicola*)	Benomyl		0.25 lb/100 gal	Dip or spray immediately after harvest.	
	Captan		1.0-1.2 lb/100 gal water	Postharvest dip, drench or spray.	
	DCNA		1 gal of 3% formulation in fruit wax or 1 gal of 9% liquid in 2 gal ready-to-use wax emulsion	Postharvest dip, drench, or spray; apply with brush to washed partially dried fruit.	
	OPP		2,000-10,000 p/m in approved wax		
	SOPP		0.4% solution; or 0.15% wax emulsion	Postharvest dip or spray or hydrocooler. Peaches only: Spray 1 gal of 0.15% emulsion/680-3,000 lb of fruit.	Rinse with potable water. Do not rinse fruit treated with wax emulsion.
	Thiophanate-methyl		8.4-11.2 oz/100 gal water; 11.7-35.1 oz/100 gal dilute wax/200,000-250,000 lb fruit	Spray or dip. In wax.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PEACHES, PLUMS, and NECTARINES					
Brown rot (*Monilinia fructicola*) (con.)	Triforine (California only)		4 oz/100 gal water/ 200,000 lb fruit	Dip or hydrocooler.	California only. Do not recirculate.
			8 oz/100 gal water/ 200,000 lb fruit	Spray.	
Rhizopus rot (*Rhizopus stolonifer*)	DCNA		Peaches: 0.75 lb/100 gal water Nectarines: 2 lb/100 gal water with wax Plums: 1 gal of 9% liquid product/ 2 gal ready-to-use wax emulsion	Postharvest dip, drench, or spray. Spray at 30-35 gal/hr of DCNA-wax combination at 18-30 psi during packing.	
	SOPP		0.4% solution	Postharvest dip, drench or spray.	Rinse fruit to avoid injury.
			Peaches only: 0.15% wax emulsion	Peaches only: Postharvest 1 gal/680 lb fruit.	Do not rinse fruit treated with wax emulsion.
Gray mold (*Botrytis cinerea*)	DCNA		Peaches: 0.75 lb/ 100 gal water as a spray; or 0.2% impregnated fruit wrap	Apply immediately after picking.	
PEAR					
Blue mold (*Penicillium* spp.) and Gray mold (*Botrytis cinerea*)	Benomyl		4 oz/100 gal	Dip or spray treatment.	
	Captan		1.0-1.2 lb/100 gal water	Postharvest, in washer, immediately after harvest.	
	SOPP		0.3-1.5% solution	Postharvest dip in dump water, or as foam.	Fruit must be rinsed to avoid injury.
Bull's-eye rot (*Neofabraea perennans*), Gray mold (*Botrytis cinerea*), and Blue mold (*Penicillium* spp.)	Thiabendazole		0.9 lb WP/100 gal water	Dip, flood, or spray. Do not treat for more than 3 minutes. Treat once before and once after storage.	Do not rinse. Do not recirculate.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PEAR					
Storage scald (physiological)	Ethoxyquin		1.50-2.25 lb/ 100 gal	Within 48 hr after harvest as a 15-second dip.	
			400 or 1,000 p/m	Paper wraps applied within 1 week after harvest.	
PEPPER (BELL)					
Postharvest decay during shipment and sales	SOPP		0.73% solution	Dip, flood, or spray to wet all surfaces thoroughly. Rinse for at least 30 seconds with potable water.	
			1.5% wax emulsion	Dip, flood, or spray.	Do not rinse.
PINEAPPLE					
Butt rot (Thielaviopsis paradoxa)	Benomyl		1-2 lb/100 gal water	Dip or spray immediately after harvest.	Do not immerse more than 5 minutes. Fresh fruit only.
	Captan		5.0 lb/100 gal water	Dip or wash harvested fruit.	
	SOPP		1% solution	Apply 1 gal per 10,000 lb of fruit in spray or foam.	
POTATO (IRISH)					
Postharvest mold, seed rot, and storage rot	Captan		1.25 lb/100 gal water	Dip washed and rinsed potatoes before drying and storage.	
RADISH					
Bacterial black spot (Xanthomonas vesicatoria var. raphani)	Calcium hypochlorite		25 p/m available chlorine	Postharvest dip for 2 minutes.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
SQUASH (prepackaged)					
Postharvest molds	Dehydro acetic acid (sodium salt)		2,000 p/m	Dip prepared squash, drain and dehydrate to original fresh weight, then package.	Limits: 2,000 p/m.
SQUASH (HUBBARD)					
Postharvest molds	Thiabendazole		0.9 lb WP/100 gal	Apply after cutting fruit from vines. Complete coverage is necessary for maximum disease control. Do not rinse after treatment.	Fresh market in Pacific northwest. Do not market treated fruit within 2 weeks after treatment.
STRAWBERRIES					
Postharvest molds	Dehydro acetic acid (sodium salt)		0.4% solution	Dip crate, lugs, or other containers 30 seconds. Drain, but do not rinse.	
SWEETPOTATO					
Rhizopus rot (Rhizopus stolonifer)	DCNA		900 p/m as wax emulsion	Postharvest foam or flooding, 1.0 gal to no less than 750 lb sweetpotatoes.	
	SOPP		0.3-0.7% solution	Postharvest on removal of roots from storage or before packaging.	Do not use on freshly harvested roots. Rinse with fresh water to avoid injury. Reduce SOPP concentration to 0.2% when roots are treated in 40-52°C water.
Black rot (Endoconidiophora fimbriata)	DCNA		0.75 lb dip or spray /100 gal water	Postharvest on removal from storage or before packaging.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
TOMATO					
Postharvest decay during shipment and sales	OPP		20,000 p/m in approved wax		
	SOPP		0.3-0.7% solutions	Apply solution by exposing fruit for 2 to 4 minutes in tank-type washer; rinse with potable water; or dip, flood, or spray fruit for 20-30 seconds, rinse at least 30 seconds with potable water.	
FRUITS AND VEGETABLES					
Postharvest bacterial diseases	Calcium hypochlorite		25 p/m available chlorine	Submerge produce for 2 minutes in wash water tank where 25 p/m available chlorine is recirculated; then spray rinse with water containing 25 p/m available chlorine.	
	Sodium hypochlorite		70 p/m available chlorine	Dip vegetables in treated water, followed by rinse in fresh tap water.	

GRASS SEED CROP DISEASES

by

John R. Hardison

ALTERNATIVE CONTROL MEASURES

Fungicides are costly and are used routinely to control only a few of the many diseases in grass and seed crops. When highly effective and reasonably priced chemicals are identified and registered for use, they can help control diseases for which present measures are unsatisfactory or unavailable. Use of such chemicals can be combined with cultural measures and others to improve control for more efficient production and better quality of grass seed.

Nature of the Problem

The cultivation of grasses for seed creates an environment favorable for development of many diseases. Some diseases may be of minor importance when the grass is used for turf or forage. In seed production, however, the dense leaf growth, especially that which develops after heavy application of nitrogen fertilizers, creates an immense natural moist chamber--essentially a microclimate--that is favorable to infection by fungi and bacteria. These difficulties are aggravated in seed crops because the development of disease is not interrupted by clipping or grazing. Seed and inflorescence diseases in seed crops must be dealt with in addition to those diseases that affect only vegetative parts of the plant.

Disease control is difficult because of unique problems in the culture of grasses. Production of grass seed is inherently trashy farming that creates conditions favorable for maximum development of diseases. Pathogens inevitably build up when inoculum is allowed to accumulate in straw and stubble during several years of continuous grass culture. These unavoidable difficulties are compounded by the impracticality of major methods used to control diseases of other plants. For instance, resistance to diseases peculiar to seed production or diseases that occur only in the West usually is not sought in breeding programs. Genetic change is not encouraged and may not be permitted in grass varieties that are developed in consuming area and submitted for seed production. Crop rotation is not practiced in the culture of long-term perennial grasses. Seed treatments have only limited value. Except for rusts, chemical control of grass diseases generally has not been feasible. All these problems are aggravated in many grass seed crops by low per-acre returns, which dictate that control methods must be inexpensive.

Field Sanitation

Under the circumstances described for grass seed production, maximum field sanitation is imperative, and simple removal of straw and stubble generally is inadequate. Burning the straw and stubble in the field fulfills the low-cost requirement and, by the generation of sterilizing heat, furnishes the necessary field hygiene.

Ergot and blind seed disease are controlled reasonably well by field burning that kills most sclerotia or infected seed that furnish the primary inoculum. Control of ergot by field burning is incomplete, and for some markets freedom from ergot is desirable. Thus, control by fire must be combined with effective chemicals when available. Sodium azide, the only chemical known to control ergot and blind seed disease, is being studied for possible use. Seed nematode is controlled by field burning, and no effective chemical is known.

Field burning has given excellent control of silver top, an insect-caused disorder that formerly was considered a disease, and it has controlled, partially, several leaf and stem diseases.

Flaming devices can provide thermal sanitation in special situations, but they expend fossil fuel extravagantly and treatments are expensive.

Other Management Practices

Disease control obtained by crop rotation recently was improved by introducing newer herbicides that allow intervening crops in the rotations to be kept free from grass or legume weeds. Fortunately, the majority of grass disease organisms do not infect both grasses and legumes. An effective rotation program for grass disease control can be obtained by growing legumes and grasses alternately for 3- or 4-year periods with application of appropriate herbicides to kill out volunteer susceptible plants in the intervening years. The disease control obtained by weed-free rotations can be nearly cost-free because the expense of weed control is justified as an agronomic practice that usually pays for itself in better seed purity and higher yields.

Many foliar diseases cause only minor damage when a crop is used for forage. This is partly because periodic harvesting of leaves and stems removes much of the disease inoculum. Harvesting forage also eliminates, temporarily, the moist chamberlike conditions and permits aeration and entrance of sunlight so that the crowns dry. These practices must be used with caution, however, to avoid reducing seed yield in grasses.

Many grasses, when spring-planted, produce a limited number of inflorescences the first fall. Other grasses produce some heads in the fall every year after the regular harvest. Where ergot is a problem, late-season heads may become infected. Clipping these heads before flowering prevents maturation of ergot sclerotia and avoids infestation of the newly planted seed production field.

Another means of sanitation important in controlling true seed diseases is to remove light-weight seed from the field during the harvesting operations. By threshing seed with a minimum of air blast, many infected seed and galls can be retained with the healthy seed. Light-weight seed then can be removed during cleaning operations away from the field, and the screenings containing diseased seed can be destroyed. Ergot sclerotia and grass seed nematode galls are poisonous to livestock, and infested screenings must not be fed to animals.

Several diseases are suppressed by burying plant residues deeply, and clean plowing with burial of old crop material can be helpful.

Irrigation methods need careful management in relation to disease control. Irrigation should be avoided if possible at flowering time to reduce conditions favorable for development of blind seed disease and ergot. Overhead irrigation should be managed during seed formation to minimize infection by foliar fungi that also may infect seed.

Deep planting of seed sometimes is an extra safeguard against disease carried with seed. It prevents emergence of the spore organs, such as those of blind seed disease and ergot. Other diseases, such as seedling blight and rotting, are favored by delayed seedling emergence and may be aggravated by deep planting.

Some diseases can be avoided by selecting proper planting dates. The value of selective seeding varies with disease problems and with local conditions. Fall seeding may control summer seedling blight of grasses in some northern areas because by the following June the plants have passed their most susceptible stage. Spring planting of certain grasses in the Pacific Northwest has permitted many grass species to escape seedling infection from soilborne spores of the common and dwarf stinking smuts.

The flowering period can be important in escaping disease infection. For example, all tall fescue strains apparently are susceptible to blind seed disease, but late-flowering types have escaped infection in western Oregon because of the advent of warm, dry weather that inhibits development of apothecia of the pathogen. Similarly, bentgrasses sometimes escape infection from primary spores of the ergot fungus because late anthesis in bentgrasses occurs in some areas during the dry periods unfavorable to formation of perithecia of the fungus.

Planting grasses on recently plowed grass sod usually is unwise because of the likelihood of injury from seedling blight, root rot, and foot rot organisms that accumulate in the old grass. Similarly, land that has produced diseased cereal crops should not be planted to grass if the grass species is susceptible to the same cereal diseases.

Considerable benefit may result from crop management when all fields of the same grass species are plowed up in the same year on a farm or, preferably, in an area. This prevents carryover of diseases that otherwise would be transferred from an old planting to new seedlings. Otherwise, the benefits from rotations, burning, and other practices are nullified partly by infestations arising in nearby untreated fields.

Variety rotation might be considered for disease control. When different crop varieties are susceptible to different races of pathogens, limiting production to certain selected varieties for a sufficient period might result in the disappearance of races unable to infect varieties being grown. Then, changing production to the second variety or related varieties would eliminate the disease races perpetuated by the first varieties grown.

Seed treatment with appropriate fungicides sometimes can be enhanced or avoided by first reducing the disease incidence. Seed disinfestation obtained by special cleaning equipment can be important for removing disease material, that is, smut spore balls, ergot sclerotia, grass seed nematode galls, and infected seed light in weight.

Aging the seed is another effective method of seed disinfestation if the grass seed outlives the pathogen under prolonged storage. Aging for 2 years is practical for disinfestation of certain grass seed infested with ergot sclerotia or for seed infected with blind seed disease. Research is needed on the effects of aging on other pathogens carried with seed, although this process can not be carried very far because of the relatively limited life of most grass seed in storage. Selection of grass seed as free as possible from disease will increase the value of treatment of the seed with appropriate chemicals.

Perspective on Fungicides and Alternative Measures

Maximum benefits from cultural methods for disease control are possible when these measures are applied areawide, as shown by the program that has nearly eliminated damage from blind seed disease and ergot to seed crops of perennial grasses in Oregon. Integrated pest management for grass seed crops starts with thermal field sanitation that stimulates economic seed yields and improves control of weeds and insects as well as diseases. Effective and affordable chemicals are sorely needed to supplement the partial control of grass diseases now obtainable by other measures in the incomplete list just described.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
GRASSES GROWN FOR SEED					
Rusts (*Puccinia striiformis*, *Puccinia poae-nemoralis*, and *Puccinia graminis*)	Maneb		1.6-2.4 lb/ 50-100 gal water/ acre WP.	Begin when rust pustules are first seen; repeat at 7-14-day intervals.	Do not graze treated areas. Do not feed clippings to livestock.
	Nickel sulfate- (19%) maneb (53%)		3.0-4.5 lb of formulation/ 50-100 gal water/ acre WP.	Three to four foliage spray applications. Start about April 15-20 or when rust is first noticed. Repeat at 2-week intervals if needed.	Do not graze treated fields or use straw or crop wastes for livestock feed.
	Propiconazol		1.8-3.6 oz/ 20 gal water/ acre EC.	Apply in late spring or early summer when rust pustules are noticeable. Repeat at 14-21-day intervals. Make last application about 2 weeks before seed matures.	Apply only in Idaho, Minnesota, Oregon, and Washington. Do not graze treated areas. Do not use any part of crop or crop waste for feed or bedding purposes.
	Triadimefon		4-8 oz/20 gal water/acre WP.	Apply when rust pustules are readily noticeable. Repeat when necessary, especially from early head emergence to late flowering.	Do not apply more than 1 lb a.i./acre/year. Do not use crop for feed or bedding. Do not plant food or forage crops on treated land within 18 months after application.
Range grasses: *Agropyron* spp. *Bromus* spp. *Elymus* spp. *Festuca* spp. Seed treatment to control infection by *Podosporiella verticillata*	Captan		2.2-9 oz/100 lb WP 6 oz/100 lb D.	Seed treatment	For the remaining chemicals on this page: Do not use treated seed for food, feed, or oil purposes.
	Thiram		3.7-4 oz/100 lb WP 4 oz/100 lb D.	Seed treatment	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
GRASSES GROWN FOR SEED					
Pearl millet (Pennisetum typhoides), Kernel smut (Tolyposporium penicillariae), and Seed decay and Damping-off organisms	Captan + Thiram (1:1)		2.1 oz/100 lb WP	Seed treatment	For the remaining chemicals on this page: Do not use treated seed for food, feed, or oil purposes.
	Thiram		1.8-2.0 oz/100 lb WP 3 oz/100 lb D.	Seed treatment	
Sorghum and sorghum x sudan hybrids, Seed decay, and Damping-off organisms	Captan		1.8-2.3 oz/100 lb WP 3 oz/100 lb D.	Seed treatment	
	Thiram		1.7-1.8 oz/100 lb WP 1.3 oz/100 lb D.	Seed treatment	
Grass seed, miscellaneous Seed decay and Damping-off organisms	Captan		2.2-9 oz/100 lb WP 6 oz/100 lb D.	Seed treatment	
	Thiram		3.7-4 oz/100 lb WP 4 oz/100 lb D.	Seed treatment	

OILSEED AND INDUSTRIAL CROP DISEASES

by

Charles A. Thomas

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ALTERNATIVE CONTROL MEASURES

Many diseases of oilseed crops can be controlled by alternative methods. With proper cultural practices, planting pathogen-free seed of good quality and of disease-resistant varieties will control seed rots adequately; many seedling diseases; and several root rots, stem rots, wilts, and foliage diseases.

Seed Rots and Seedling Diseases

Planting good-quality seed (seed that will produce vigorous seedlings) in soil at the optimum temperature for germination and with ample but not excessive moisture will eliminate or greatly reduce seed rot and many seedling diseases. Since several seedling diseases are caused by seedborne pathogens, the use of disease-free seed is advisable.

Root Rots, Stem Rots, and Wilts

Proper cultural practices and the use of disease-resistant cultivars control several root rots, stem rots, and wilts. Rotation with crops immune to the pathogens and selection of fields known to be free, or relatively free, of the pathogens are effective measures. Avoiding poorly drained areas and furrow-irrigating bed plantings help control root and stem rots associated with wet soils. Prevention of drought stress by timely irrigations will reduce the severity of many soilborne diseases. Burying plant debris by clean plowing and nondirting cultivation for weed control are helpful. Integrating these practices with the use of resistant or tolerant cultivars will minimize the incidence of these diseases.

Foliage Diseases

Since many pathogens that cause leaf spots, rust, or blights are seedborne, the use of disease-free seed will reduce the occurrence of these diseases. Crop rotation and clean plowing are helpful. Cultivars resistant to some diseases are available.

New cultivars, some with combined resistance to several diseases, are being developed. Their use, when available, will lessen our dependence on pesticides. Biological control methods are being studied. When perfected, such methods will provide other alternative methods of control.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
FLAX					
Pasmo (Mycosphaerella linorum), Damping-off and seed decay	Captan	—*	1.9 oz/100 lb SL or 2.7 oz/100 lb D	Seed treatment only.	Do not use treated seed for food, feed, or oil.
HOPS					
Downy mildew (Pseudoperonospora humuli)	Zineb	14	1.125-1.5 lb/100 gal 1.1-3.0 lb/acre	Apply 100-200 gal/acre according to foliage density at weekly intervals after growth starts.	
PEANUT					
Leaf spots (Cercosporidium personatum and C. arachidicola)	Benomyl + Mancozeb	14	0.125 lb + 0.8-1.2 lb in sufficient water/acre	Begin when disease first appears; repeat at 10-14-day intervals, or at 7-day intervals in humid weather.	Do not graze or feed treated vines, hay or hulls to livestock.
	Chlorothalonil	14	0.75-1.125 lb in sufficient water/acre	Begin when disease first appears; repeat at 10-14-day intervals, more frequently under severe conditions.	Do not graze treated areas. Do not use hay or threshings from treated fields as feed.
	Copper hydroxide - sulfur (1:35)	—*	13.5-22.5 lb D/acre, which contains 0.24-0.40 metallic copper	Begin when spots first appear on lower leaves. If a heavy rain occurs within 24 hr after first application, repeat in 3-7 days, otherwise repeat at 10-14-day intervals.	Do not feed treated forage to dairy animals or animals being finished for slaughter.
	Fentin hydroxide	14	0.17 lb in sufficient water/acre	Begin when disease first appears; repeat at 10-14-day intervals, more frequently under severe conditions.	
	Mancozeb	14	0.8-1.6 lb in sufficient water for thorough coverage/acre	Begin when disease first appears; repeat at 10-14-day intervals, or at 7-day intervals in humid weather.	Do not feed treated vines to livestock.
	Sulfur	—*	18-24 lb/acre	Begin when disease first appears; repeat at 10-14-day intervals, more frequently under severe conditions.	No limitation on preharvest application or hay. May burn foliage if temperature is high. Corrosive to equipment.

* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PEANUT					
Stem rot or Southern blight (*Sclerotium rolfsii*)	PCNB	—*	10.0 lb/12,400 linear ft of row	At pegging time in 12-inch band as soil surface treatment over the row.	Do not feed treated peanut hay to livestock. Do not use dust formulations.
Rust (*Puccinia arachidis*)	Chlorothalonil	14	1.125 lb in sufficient water/acre	Begin when disease first appears; repeat at 10-14-day intervals, more frequently under severe conditions.	Do not graze treated areas. Do not use hay or threshings from treated fields as feed.
Damping-off and seed decay	(See seed treatment lists - captan, maneb, and thiram.)				
SAFFLOWER					
Rust (*Puccinia carthami*) Damping-off, and seed decay	Mancozeb	—*	1.4 oz/100 lb	Seed treatment (slurry).	Do not use treated seed for food, feed, or oil.
	PCNB	—*	0.5-1 oz/100 lb; see label	Seed treatment (slurry).	Do not use treated seed for food, feed, or oil.
	TCMTB	—*	1 oz/100 lb	Seed treatment (slurry).	Do not use treated seed for food, feed, or oil.
	Thiram	—*	2 oz/100 lb	Seed treatment (slurry).	Do not use treated seed for food, feed, or oil. Not for rust.

* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
SOYBEANS					
Stem, pod, seed, and foliar diseases	Benomyl	35	0.25-0.50 lb/acre	For determinate varieties (generally grown in the south) apply at early pod set when majority of pods are 1/8 to 1/2 inch in length; for indeterminate varieties (generally grown in the north), apply when pods near the top of the plant are 1/2 to 1 inch in length. Make one additional application 14 to 21 days later.	Do not graze or feed treated soybean vines to livestock.
	Thiabendazole	21	2.8-4.7 oz/acre flowable	Apply at early pod set when the pods on the lower third of the plant are no more than 1/8 to 1/4 inch long. Apply second application 2 weeks later (ground or aerial application). Do not mix with copper fungicides.	Do not feed treated soybean vines or hay to livestock.
Seedling diseases	Chloroneb	--*	0.975 lb/12,000 to 14,000 row ft/acre	In-furrow spray at planting time using 10 to 20 gal water per acre. Use a pressure sprayer equipped with dual row nozzles, one nozzle directed downward to the seed in the open furrow and the other backward into the covering soil.	Do not use treated seed for food, feed, or oil purposes. Do not graze treated soybeans within 45 days of planting.
Seedling diseases and damping-off	Captan	—*	1 oz/100 lb	Seed treatment (planter box treatment).	Do not use treated seed for food, feed, or oil.
	Chloroneb	—*	2.6 oz/100 lb	Applied as a supplemental seed treatment or seed overcoating with thiram. Applied as a slurry.	Do not use treated seed for food, feed or oil purposes. Do not graze treated soybeans within 45 days of planting.
	PCNB-Etridiazole (1:4)	—*	0.5-1 oz/bu	Seed treatment (planter box or slurry).	Do not use treated seed for food, feed, or oil.
	Thiram	—*	2 oz/100 lb	Seed treatment (dry or slurry).	Do not use treated seed for food, feed, or oil purposes.

* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
SOYBEANS					
General seedling diseases, damping-off, and insect problems on stored seed	Thiram (70%) plus Methoxychlor (2%)	—*	1.33 oz/100 lb	Seed treatment for stored soybeans and general seed treatment (slurry).	Do not use treated seed for food, feed, or oil.
SUNFLOWER					
Damping-off and seed decay	Captan	—*	0.5 oz/100 lb	Seed treatment (dry).	Do not use treated seed for food, feed, or oil.

USE PESTICIDES SAFELY – READ THE LABEL

* Does not apply.

SHADE TREE DISEASES

by

Lawrence R. Schreiber

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ALTERNATIVE CONTROL MEASURES

Several nonpesticidal techniques can be used alone or in conjunction with pesticides to control plant diseases. These cultural practices include:

1. Choosing the proper species and cultivars suited for your soil and climatic conditions. When possible, plant disease-resistant trees.
2. Picking only vigorous, healthy plants free of insects and diseases. Learn the proper way to plant your trees so that they become well established. Then, maintain them by initiating the proper watering and fertilizing schedule.
3. Avoiding wounding that weakens the tree and provides courts of entry for disease organisms. Wrap newly planted, thin-bark trees to avoid winter injury. Practice proper pruning techniques to avoid unsightly and damaging wounds. Do not injure the bark on tree trunks when mowing or weeding around the base.
4. Practicing proper sanitation. Remove and dispose of damaged or diseased trees or tree parts. The diseased plant tissue may serve as a source of reinfection of healthy trees. Remove weeds or other plants that are hosts or alternate hosts for disease organisms that may infect trees that you wish to protect.

The following specific cultural practices can help prevent or reduce the severity of disease incidences for the following host plants:

Specific Alternative Control Measures

ASH

Anthracnose (*Gloeosporium aridum*): Rake and burn fallen leaves. Fertilize trees to maintain vigor.

CRABAPPLE

Fire blight (*Erwinia amylovora*): Remove infected branches 8-12 in below diseased tissue and destroy them. Avoid excess nitrogen fertilizer. Plant disease-resistant cultivars.

Scab (*Venturia inaequalis*): Rake and burn fallen leaves. Plant disease-resistant cultivars.

DOGWOOD

Crown canker (*Phytophthora cactorum*): Trim out infected tissue in the cankered area. If the canker girdles the trunk, remove the tree. Avoid wounding the trunk. Fertilize to maintain plant vigor.

ELM

Dutch elm disease (*Ceratocystis ulmi*): Prune out the diseased branches so as to remove 5-10 ft of nondiscolored wood, in addition to all of the disease-discolored wood. Plant resistant cultivars.

HAWTHORN

Fire blight (*Erwinia amylovora*): Plant disease-resistant cultivars.

Leaf spot (*Fabraea thuemenii*): Plant disease-resistant cultivars.

MAPLE

Tar spot (*Rhytisma acerinum*): Destroy fallen leaves.

Leaf spots (*Phleospora aceris*, *Phyllosticta minima*, *Septogloeum acerinum*): Destroy fallen leaves.

MOUNTAIN ASH

Fire blight (*Erwinia amylovora*): Prune infected branches 6-10 in below visibly infected areas and destroy them.

Canker (*Cytospora rubescens*, *Physalospora obtusa*): Maintain plant vigor and protect from winter injury. Prune out diseased branches.

OAK

Leaf spots (*Actinopelte* spp.): Destroy fallen leaves. Improve plant vigor.

PINE

Lophodermium needle cast (*Lophodermium pinastri*): Control weeds and remove shade-causing plants around pines if possible.

Needle blister rust (*Coleosporium asterum*): Destroy goldenrod and asters (alternate hosts) near plants to be protected.

Tip blight (*Cenangium ferruginosum*): Cut off and destroy infected twigs.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ASH					
Anthracnose (*Gloeosporium aridum*)	Benomyl		4 oz/100 gal	Apply when buds break in the spring and repeat when leaves are half grown and again when full grown.	
CRABAPPLE					
Rust (*Gymnosporangium clavipes*)	Zineb		12 oz/100 gal	Apply 3 times at 10-day intervals, starting when flower buds open.	
Fire blight (*Erwinia amylovora*)	Streptomycin sulfate		50-100 p/m	Apply to blooms at 5-7-day intervals; 10-14-day intervals after petal fall to control twig blight.	
Scab (*Venturia inaequalis*)	Captan + Benomyl		12 oz + 4 oz/100 gal	Spray at 7-10-day intervals starting when green shows on flower buds. In wet seasons, it may be necessary to spray in midsummer.	
DOGWOOD					
Crown canker (*Phytophthora cactorum*)				See alternative control measures.	
Leaf spot (*Cercospora cornicola*, *Septoria cornicola*)	Zineb		12 oz/100 gal	Spray when buds open. Repeat 2-3 times at monthly intervals.	

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ELM					
Dutch elm disease (Ceratocystis ulmi)	MBC phosphate		1 gal 0.6% product/ 3 gal water	Protective injections should be made into roots or trunk when leaves reach half to full development. Repeat every second year. Inject into roots at rate of 2 qt per inch diameter or into trunk for every 3 in circumference at breast height.	To be used only by trained arborists in conjunction with a program of sanitation and insect control.
	MBC phosphate		1 gal 0.6% product/ gal water	Treat infected trees when leaf symptoms involve less than 10% of the foliage. Inject in the roots and trunk as with protective treatments. In addition, inject limbs with disease symptoms. Prune diseased limb 2-10 days following injection. Remove 5-10 ft of undiscolored wood as well as all of the disease-discolored wood.	
	Thiabendazole hypophosphite		1 fl oz 26.6% product/40 fl oz water	Protective injections should be made at the rate of 1-2 oz for each 5 in trunk diameter. Apply when leaves approach full size. To treat infected trees, apply 2-4 oz for each 5 in of trunk diameter. Apply to trees with 5 percent or less foliar symptoms.	To be used only by trained arborists and others trained in the identification of Dutch elm disease and injection techniques.
Anthracnose or Black leaf spot (Gnomonia ulmea)	Bordeaux mixture		4 lb Copper sulfate + 4 lb Lime/100 gal	Apply as leaves unfold in spring; repeat in 2-3 weeks.	
HAWTHORN					
Fire blight (Erwinia amylovora)	Streptomycin sulfate		50-100 p/m	See Crabapple-Fire blight.	
Leaf spot (Fabraea thuemenii)	Zineb		18 oz/100 gal	Apply when leaves unfold and 2-3 times at 10-day intervals.	
Rust (Gymnosporangium globosum)	Zineb		18 oz/100 gal	Apply when leaves unfold and continue at 10-day intervals through blossoming.	

SHADE TREE DISEASES

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
HICKORY					
Anthracnose (*Gnomonia caryae*)	Zineb		18 oz/100 gal	See Ash-Anthracnose.	
HORSE CHESTNUT					
Leaf blotch (*Guignardia aesculi*) Anthracnose (*Glomerella cingulata*)	Zineb		18 oz/100 gal	See Ash-Anthracnose.	
MAPLE					
Anthracnose (*Gloeosporium apocryptum*)	Zineb		18 oz/100 gal	See Ash-Anthracnose.	
Tar spot (*Rhytisma acerinum*)	Bordeaux mixture		4 lb Copper sulfate + 4 lb Lime/100 gal	Apply as leaves unfold and repeat in 2-3 weeks.	
Leaf spots (*Phleospora aceris*, *Phyllosticta minima*, *Septogloeum acerinum*)	Bordeaux mixture		4 lb Copper sulfate + 4 lb Lime/100 gal	Spray when new leaves unfold and 2-3 times at 10-day intervals.	
MOUNTAIN ASH					
Fire blight (*Erwinia amylovora*)				See alternative control measures.	
Canker (*Cytospora rubescens*, *Physalospora obtusa*)				See alternative control measures.	

SHADE TREE DISEASES

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
OAK					
Anthracnose (*Gloeosporium quercinum*)	Zineb		18 oz/100 gal	See Ash-Anthracnose.	
Leaf spots (*Actinopelte* spp.)				See alternative control measures.	
Leaf blister (*Taphrina caerulescens*)	Fixed copper (basic copper sulfate)		2.2 lb plus 2.0 lb Hydrated lime/100 gal	Apply before buds open in spring.	
PINE					
Lophodermium needlecast (*Lophodermium pinastri*)	Maneb		1.2 lb/100 gal	Apply monthly August-October.	
Fusiform rust (*Cronartium fusiforme*)	Ferbam		0.76-1.5 lb/100 gal	Apply at 3-7-day intervals from plant emergence as needed.	Used on pine seedlings in nursery beds.
	Ziram		1.5 lb/100 gal	Apply at 3-5-day intervals from emergence to mid-June. Add suitable wetting agent.	
Needle blister rust (*Coleosporium asterum*)	Ferbam		0.76-1.5 lb/100 gal	Apply at leaf emergence and at 7-10-day intervals as needed.	
Tip blight (*Cenangium ferruginosum*)	Bordeaux mixture		4 lb Copper sulfate + 4 lb Lime/100 gal	Apply just before new growth starts, followed by 2 more applications at 14-day intervals.	
SYCAMORE					
Anthracnose (*Gnomonia platani*)	Benomyl		4 oz/100 gal	See Ash-Anthracnose.	

TREE-NUT DISEASES

by

Richard E. Hunter

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Pecan	152		

ALTERNATIVE CONTROL MEASURES

Fungicides applied to cover plant parts thoroughly at the proper times offer the best means of controlling foliage and nut diseases. In some instances, however, cultural practices and host-plant resistance will reduce the need for fungicides.

Cultural Practices

Most foliage diseases are favored by high humidity and splashing water. Thus, such practices as keeping irrigation sprinklers from wetting the foliage and providing good air flow through the orchard will be beneficial to the health of nut trees.

Trees low in vigor are more susceptible to some diseases. Adequate fertilization will help minimize the damage from anthracnose to black walnuts and from brown leaf spot and leaf blotch to pecans.

The bacterial blight organism of filbert enters parts of the tree through wounds from pruning, machinery, and frost damage. Thus, such wounds should be avoided or treated promptly.

Cleaning the orchard of diseased plant parts will reduce the number of spores of some fungi that cause diseases and aid in their control. Wood of filbert trees infected with Eastern filbert blight should be pruned and burned. Shaking old shucks and leaf stems out of pecan trees before they leaf out in the spring will reduce the chance of infection by the pecan scab fungus.

Zonate leaf spot of pecan has several other hosts, including native trees, that are apt to be growing near orchards in the Southeast. Clearing wild trees from fence rows and waste places near pecan orchards will reduce damage from zonate leaf spot.

Host-Plant Resistance

Pecan varieties differ in their susceptibility to downy spot and scab. Numerous races of the scab organism exist. Some pecan varieties are susceptible to most races, other varieties are susceptible to only some races, and a small number of varieties are resistant to most or all races. In humid areas where scab can be a serious problem, planting varieties that have a high level of resistance will reduce the need for fungicides. Resistance to downy spot evidently is controlled by genes that are different from those resistant to scab. Downy spot is generally less severe than scab; therefore, resistance to scab is preferred if resistance to both diseases does not occur in the pecan varieties adapted to your locality. Information on the disease resistance of varieties adapted to a particular location can be obtained from the extension service in your State.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ALMOND					
Brown rot (*Monilinia laxa*)	Benomyl	NTL*	0.5-0.75 lb/acre WP	Apply at pink bud. Under severe conditions, apply again during half- to full-bloom.	
	Captan	12	0.4-1.0 lb/100 gal WP, flowable 2.5-5.0 lb/acre D	Apply at popcorn, bloom, petal fall stages, and up to 5 weeks after petal fall.	May be used up to 12 days of harvest if hulls are not fed to dairy animals or animals being finished for slaughter.
	Copper ammonium carbonate + sulfur (8:5)	NTL*	1.5-2.3 lb MCE** L /100 gal	Apply at delayed dormant bud swell stage.	
	Copper hydroxide	NTL*	1-1.5 lb MCE** WP /100 gal	Full cover spray; do not apply after bloom to avoid spray injury.	
	Copper oxychloride sulfate	NTL*	2 lb MCE** WP/100 gal 2.4-3.0 lb MCE** D /acre	Apply in preblossom and petal fall stages.	
	Fixed copper (basic copper sulfate)	NTL*	1.1-2.7 lb MCE** WP /100 gal 2.8-3.5 lb MCE** D /acre	Apply through swelling bud and popcorn stage. Do not apply after 50% bloom or when trees are in leaf.	
	Fixed copper (basic copper sulfate) + sulfur	NTL*	0.25-0.5 lb MCE** FS /100 gal plus 2.8-5.5 lb FS/100 gal	Apply through swelling bud stage to popcorn stage. Do not apply after 50% bloom or when trees are in leaf.	
	Sodium pentachlorophenate	NTL*	2.4-3.2 lb WP /100 gal	Apply after the spore mats appear on twigs, but before bud scales begin to separate as it may kill blossoms. In most locations this will be mid-January. Do not apply after bud scales have begun to separate. Do not apply within 3 weeks of an oil spray.	
	Ziram	Do not use later than 5 weeks after petal fall.	1.5 lb/100 gal WP	Apply in prebloom, blossom, and petal fall periods.	Do not use later than 5 weeks after petal fall.

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* No time limit.

** Metallic copper equivalent.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ALMOND					
Scab (*Cladosporium carpophilum*)	Captan	12	1 lb/100 gal WP	Apply at popcorn, bloom, petal fall stages, and up to 5 weeks after petal fall.	May be used up to 12 days of harvest if hulls are not fed to dairy animals or animals being finished for slaughter.
	Ziram	Do not use later than 5 weeks after petal fall.	1.5 lb/100 gal WP	Apply at petal fall and 5 weeks after petal fall.	Do not use later than 5 weeks after petal fall.
Shot hole (*Coryneum beijerinckii*)	Captan	12	1 lb/100 gal WP	Apply at popcorn, bloom, petal fall stages, and up to 5 weeks after petal fall.	May be used up to 12 days of harvest if hulls are not fed to dairy animals or animals being finished for slaughter.
	Fixed copper (basic copper sulfate)	NTL*	2.7 lb MCE** WP /100 gal	Apply as a dormant spray Dec. 15-Jan. 15.	
			1.1-2.7 lb MCE** WP /100 gal 2.8-3.5 lb MCE** D /acre	Apply through swelling bud and popcorn stage. Do not apply after 50% bloom or when trees are in leaf.	
	Fixed copper (basic copper sulfate) + sulfur	NTL*	0.25-0.5 lb MCE** FS /100 gal plus 2.8-5.5 lb FS/100 gal	Apply as a dormant spray Dec. 15-Jan. 15.	
	Copper-zinc sulfate complex	NTL*	1.1-1.5 lb MCE** WP /100 gal	Use WP in combination with a superior or supreme type oil as a sticker. Apply during swelling bud and popcorn stage.	
	Copper oxychloride sulfate	NTL*	2.0 lb MCE** WP /100 gal plus 1.5-2.0 gal oil emulsion.	Apply as fall spray, in spring at bud swell and at petal fall.	
	Ziram	Do not use later than 5 weeks after petal fall.	1.5 lb/100 gal WP	Apply in prebloom, blossom, and petal fall periods.	Do not use later than 5 weeks after petal fall.

* No time limit.
** Metallic copper equivalent.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ALMOND					
Leaf blight (*Hendersonia rubi*)	Captan	12	1 lb/100 gal WP	Apply at popcorn, bloom, petal fall stages and up to 5 weeks after petal fall.	May be used up to 12 days of harvest if hulls are not fed to dairy animals or animals being finished for slaughter.
	Sodium pentachlorophenate	NTL*	2.4-3.2 lb/100 gal WP	Dormant application only; ground application only. Do not apply within 3 weeks of an oil spray.	
	Ziram	Do not use later than 5 weeks after petal fall.	1.5 lb/100 gal WP	Apply in prebloom, blossom, and petal fall periods.	Do not use later than 5 weeks after petal fall.
FILBERT					
Bacterial blight (*Xanthomonas corylina*)	Copper hydroxide	NTL*	2-3 lb MCE** WP/100 gal plus 1 pint superior type oil.	Apply in late August or early September. In seasons of heavy rainfall, apply another spray when three-fourths of the leaves have dropped.	
	Copper oxychloride sulfate	NTL*	2.4-3.0 lb MCE** D /acre	Apply as necessary to maintain control.	
PECAN					
Scab (*Cladosporium caryigenum*)	Benomyl	Do not apply after shuck split.	0.25-0.5 lb/acre WP	Apply at prepollination when young leaves are unfolding, when small nuts are forming, and thereafter at 3-4-week intervals.	

* No time limit.
** Metallic copper equivalent.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PECAN					
Scab (*Cladosporium caryigenum*) (con.)	Dodine	Do not apply after shucks have started to open.	0.33-0.65 lb/100 gal WP by ground equipment. 1.3-2.6 lb/acre WP in 20 gal or more by aircraft.	Begin applications when first leaves are showing and repeat at 10-14-day intervals through first cover. Repeat applications at 2-3-week intervals or as needed to maintain disease control.	Do not graze meat or dairy animals in treated groves. Moore, Van Deman, and other varieties may be injured.
	Fentin hydroxide	Do not apply after shucks have started to open.	0.1-0.3 lb/100 gal WP by ground equipment. 0.36-0.7 lb/acre WP in 20 gal or more by aircraft.	Begin applications at pre-pollination stages when the young nuts are unfolding, and a second application when the small nuts are forming. Repeat spray applications at 2-4-week intervals as needed to maintain control.	Do not graze dairy or meat animals in treated areas.
	NIA 9102	Do not apply after shuck split.	1.6 lb/100 gal WP by ground equipment. 6.4 lb/acre WP in 20 gal or more by aircraft or mistblower.	Begin applications when buds are bursting and first leaves are showing. Repeat in 10 to 14 days or when first leaves are half grown. Apply a third application when the tips of the small nuts have turned brown. Repeat as required to maintain control.	Do not graze animals on treated areas.
Brown leaf spot (*Cercospora fusca*), Downy spot (*Mycosphaerella caryigena*), Liver spot (*Gnomonia caryae* var. *pecanae*), and Powdery mildew (*Microsphaera alni*)	Benomyl	Do not apply after shuck split.	0.25-0.5 lb/acre WP	Apply at prepollination when young leaves are unfolding, when small nuts are forming, and thereafter at 3-4-week intervals.	
	Dodine	Do not apply after shucks have started to open.	0.33-0.65 lb/100 gal WP by ground equipment. 1.3-2.6 lb/acre WP in 20 gal or more by aircraft.	Begin applications when first leaves are showing and repeat at 10-14-day intervals through first cover. Repeat applications at 2-3-week intervals or as needed to maintain disease control.	Do not graze meat or dairy animals in treated groves. Moore, Van Deman, and other varieties may be injured.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PECAN					
Brown leaf spot (*Cercospora fusca*), Downy spot (*Mycosphaerella caryigena*), Liver spot (*Gnomonia caryae* var. *pecanae*), and Powdery mildew (*Microsphaera alni*) (con.)	Fentin hydroxide	Do not apply after shucks have started to open.	0.1-0.3 lb/100 gal WP 0.36-0.7 lb/acre WP in 20 gal or more by aircraft.	Begin applications at prepollination stages when the young nuts are unfolding, and a second application when the small nuts are forming. Repeat spray applications at 2-4-week intervals as needed to maintain control.	Do not graze dairy or meat animals in treated areas.
Sooty mold (*Capnodium* sp.)	Fentin hydroxide	Do not apply after shucks have started to open.	0.1-0.3 lb/100 gal WP 0.36-0.7 lb/acre WP in 20 gal or more by aircraft.	Begin applications at prepollination stages when the young nuts are unfolding, and a second application when the small nuts are forming. Repeat spray applications at 2-4-week intervals as needed to maintain control.	Do not graze dairy or meat animals in treated areas.
Leaf blotch (*Mycosphaerella dendroides*)	Dodine	Do not apply after shucks have started to open.	0.33-0.65 lb/100 gal WP by ground equipment. 1.3-2.6 lb/acre WP in 20 gal or more by aircraft.	Begin applications when first leaves are showing and repeat at 10-14-day intervals through first cover. Repeat applications at 2-3-week intervals or as needed to maintain disease control.	Do not graze meat or dairy animals in treated groves. Moore, Van Deman, and other varieties may be injured.
	Fentin hydroxide	Do not apply after shucks have started to open.	0.1-0.3 lb/100 gal WP 0.36-0.7 lb/acre WP in 20 gal or more by aircraft.	Begin applications at prepollination stages when the young nuts are unfolding, and a second application when the small nuts are forming. Repeat spray applications at 2-4-week intervals as needed to maintain control.	Do not graze dairy or meat animals in treated areas.
Fungal leaf scorch and Zonate leaf spot (*Cristulariella pyramidalis*)	Benomyl	Do not apply after shuck split.	0.25-0.5 lb/acre WP	Apply at prepollination when young leaves are unfolding, when small nuts are forming, and thereafter at 3-4-week intervals.	
Vein spot (*Gnomonia nerviseda*)	None currently registered. Sprays for other diseases usually provide control.				

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
WALNUT (black) Anthracnose or Leaf blotch (*Gnomonia leptostyla*)	Dodine	Do not apply after hulls begin to split.	0.65 lb/100 gal WP	Apply when leaves first unfold; repeat applications at 10-14-day intervals.	Do not graze meat or dairy animals in treated groves.
WALNUT Blight (*Xanthomonas juglandis*)	Copper ammonium carbonate	NTL*	1.0-1.5 lb MCE** L/acre	Make first application at early prebloom, second application at late prebloom. Make additional applications if disease conditions persist.	
	Copper hydroxide	NTL*	1.0-2.2 lb MCE** WP/100 gal <3-6.4 lb MCE** WP/acre	Apply first spray at early prebloom when catkins are partially expanding. Make three additional applications during bloom and early nutlet stage at 7-10-day intervals. Additional applications may be necessary when when frequent rainfall occurs.	
	Copper oxychloride sulfate	NTL*	1.5-2.5 lb MCE** WP/100 gal 1.2-3.0 lb MCE** D/acre	Apply at 1% pistillate bloom and again at 10-20% pistillate bloom.	
	Copper-zinc sulfate complex	NTL*	1.14 lb MCE** WP/100 gal 2.2-2.5 lb MCE** D/acre	Use WP in combination with a superior or supreme type oil as a sticker. Apply during early or late prebloom. Make two applications, the first at early prebloom stage, the second application at prebloom stage. Also one or two postbloom applications as required during damp weather.	
	Fixed copper (basic copper sulfate)	NTL*	1.2-1.5 lb MCE** FS/100 gal 1.1-2.6 lb MCE** WP/100 gal 2.2-3.5 lb MCE** D/acre	Make first application in late prebloom just before the majority of the flowers come into full bloom and the second in the postbloom period when plumules at the tips of the nutlets are withering. Repeat applications 3-4 times during growing season if necessary.	

USE PESTICIDES SAFELY — READ THE LABEL

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* No time limit.
** Metallic copper equivalent.

TURFGRASS DISEASES

by

Stanley A. Ostazeski

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ALTERNATIVE CONTROL MEASURES

Since lawn grasses usually are grown in monoculture, which is an extremely artificial condition, they are more subject to diseases than they would be in a natural environment of mixed species. Nevertheless, the impact of diseases can be lessened by: (1) using only adapted grasses chosen for the soil, climate, and light conditions under which they will grow and (2) spending the necessary time, effort, and money in caring for the grass. Disease control is impossible without proper management, including proper fertilization, irrigation, mowing, and insect and weed control. Some important practices that alleviate disease risks follow:

Use of Resistant Varieties and Mixtures

Since Kentucky bluegrass varieties made available in recent years are fairly resistant to

Helminthosporium leaf spot, powdery mildew, rust, and stripe smut, they should be considered when new lawns are being established. When Kentucky bluegrass will be subject to severe, annual disease stress, pure stands should be avoided, if possible. Mixtures of several recommended species of similar morphology usually retard disease development because mixtures contain naturally resistant species.

Fertilization

Apply only enough fertilizer to keep grass healthy and thriving. Split total fertilizer requirement into partial applications two to several times per year. Avoid overstimulation of growth through excessive nitrogen use. Apply lime if soil tests indicate a need.

Mowing

Do not clip Kentucky bluegrass or fescues below 1-3/4 inches. Zoysias, bentgrasses, and Bermudagrasses may be clipped as low as 1/2 inch. When regular mowing has been delayed due to such conditions as inclement weather, do not remove more than one-half of the leaf surface at one time. Remove clippings from lawns that have been fertilized heavily.

Irrigation

Do not water grass until it begins to wilt; then soak the soil to a depth of 6 inches or more. Avoid frequent, shallow sprinklings. Apply water early enough in the day to allow leaves to dry before night. Excessive water favors development of diseases caused by *Rhizoctonia* and *Pythium*.

Disease and Crop	Fungicide	Ounces of active ingredient to apply per 1,000 sq. ft. unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
Brown patch (*Rhizoctonia solani*) Bentgrasses Bluegrasses Bermudagrass Ryegrass St. Augustinegrass Zoysiagrasses Centipedegrass Fine leaf fescues Tall fescue	Anilazine	2-4 WP	During warm, humid weather, every 5-14 days.	For all chemicals on this page: Do not graze treated areas. Do not feed clippings to livestock.
	Benomyl	1 WP	Apply as a drench when disease first appears; repeat at 10-14-day intervals as long as needed; at 5-7-day intervals if disease is unusually severe.	
	Cadmium chloride	1 of 20.1% L formulation.	June-September, every 10-14 days.	
	Chlorothalonil	3.2-4.3 WP	Begin before disease appears; repeat at 7-14-day intervals throughout the season.	
	Fenarimol	0.2 WP	Begin when disease appears; repeat at 7-day intervals until disease is controlled. Use every 14 days to maintain control.	
	Folpet-Cadmium carbonate-Thiram (12:1:2)	WP, follow manufacturer's directions.		
	Iprodione	0.75-1 WP	During warm, humid weather, every 7-10 days.	
	Mancozeb (turf formulation).	4 of WP formulation	Begin when grass greens up in spring; repeat at 7-14-day intervals throughout the season.	
	Maneb	2.4-6.4 WP in sufficient water.	Begin when disease first appears; repeat at 7-14-day intervals.	
	PCNB	WP, follow manufacturer's directions.		
	Thiabendazole	0.5-1.2 WP	Begin when disease first appears; repeat at weekly intervals.	Not for bentgrasses.
	Thiophanate	1 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	

Disease and Crop	Fungicide	Ounces of active ingredient to apply per 1,000 sq. ft. unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
Brown patch (Rhizoctonia solani) Bentgrasses Bluegrasses Bermudagrass Ryegrass St. Augustinegrass Zoysiagrasses Centipedegrass Fine leaf fescues Tall fescue (con.)	Thiophanate-methyl	0.525-1.05 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	For all chemicals on this page: Do not graze treated areas. Do not feed clippings to livestock.
	Thiram	4.5 WP	Begin when disease is first noticed; repeat at 7-10-day intervals as necessary.	
	Triadimefon	0.25-0.5 WP	Apply recommended rate at 15-30-day intervals.	
Copper spot (Gloeocercospora sorghi) Bentgrasses	Anilazine	2-4 WP	During warm, humid weather, every 5-14 days.	
	Cadmium chloride	1 of 20.1% L formulation.	June-September, every 10-14 days.	
	Cadmium sebacate 5.0% Potassium chromate 5.0% Malachite green 1.0% Auramine 0.5% Thiram 16%	2-8 oz of WP product		
	Cadmium succinate	0.3 WP	Begin when disease is first noticed; repeat at 1-week intervals until disease is controlled.	
	Captan	1.6 WP	Begin when growth starts in spring; repeat at 7-14-day intervals throughout the season.	
	Chlorothalonil	3.2-4.3 WP	Begin before disease appears; repeat at 7-10-day intervals. Use a 7-day schedule for curative purposes or under conditions favoring disease development.	
	Mancozeb (turf formulation).	4 of WP formulation	Begin when grass greens up in spring; repeat at 7-14-day intervals throughout the season.	

Disease and Crop	Fungicide	Ounces of active ingredient to apply per 1,000 sq. ft. unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
Copper spot (*Gloeocercospora sorghi*) Bentgrasses (con.)	Thiophanate	1 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	For all chemicals on this page: Do not graze treated areas. Do not feed clippings to livestock.
	Thiram	2-3.5 WP	Begin when disease is first noticed; repeat at 7-10-day intervals as necessary.	
Dollar spot (*Sclerotinia homoeocarpa*) Bentgrasses Bluegrasses Bermudagrass Ryegrass Fescues Zoysiagrasses St. Augustinegrass Centipedegrass	Anilazine	2-4 WP	During warm, humid weather, every 5-14 days.	
	Benomyl	0.5 WP	Apply as a drench when disease first appears; repeat at 10-14-day intervals.	
	Cadmium chloride	1 of 20.1% L formulation.	June-September, every 10-14 days.	
	Cadmium succinate	0.3 WP	Begin when disease is first noticed; repeat at 1-week intervals until disease is controlled.	
	Chlorothalonil	2.1-4.3 WP	Begin before disease appears; repeat at 7-14-day intervals. Use a 7-day schedule for curative purposes or under severe disease conditions.	
	Cycloheximide-Thiram (1:100)	WP, follow manufacturer's directions.	Disease can occur from May to October. Spray at 7-14-day intervals until disease is controlled.	
	Fenarimol	0.1-0.2 WP	Begin at high rate when disease appears; repeat at 14-day intervals until disease is controlled. Use low rate every 21 days to maintain control.	
	Folpet-Cadmium carbonate-Thiram (12:1:2)	WP, follow manufacturer's directions.		
	Iprodione	0.75-1 WP	Begin when disease is first noticed; repeat every 7-14 days until disease is controlled.	

Disease and Crop	Fungicide	Ounces of active ingredient to apply per 1,000 sq. ft. unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
Dollar spot (*Sclerotinia homoeocarpa*) Bentgrasses Bluegrasses Bermudagrass Ryegrass Fescues Zoysiagrasses St. Augustinegrass Centipedegrass (con.)	Mancozeb (turf formulation).	4-6 of WP formulation.	Begin when grass greens up in spring; repeat at 7-14-day intervals throughout the season.	For all chemicals on this page: Do not graze treated areas. Do not feed clippings to livestock.
	Maneb	WP, 4.8-6.4 in sufficient water.	Begin when disease first appears; repeat at 7-14-day intervals.	
	Thiabendazole	0.5-1.2 WP	Apply from spring to October. Treat at 7-14-day intervals until disease is controlled.	Not for bentgrasses.
	Thiophanate	1 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	
	Thiophanate-methyl	0.52-1.05 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	
	Thiram	4.5 WP	Begin when disease is first noticed; repeat at 7-14-day intervals as necessary.	
	Triadimefon	0.25-0.5 WP	Apply recommended rate at 30-day intervals.	
	Vinclozolin	1 WP	Begin when disease is first noticed; repeat in 1-3 weeks while disease conditions prevail.	
Fading out (*Curvularia* spp.) Most turfgrasses	Cadmium chloride	1 of 20.1% L formulation.	June-September, every 10-14 days.	
	Chlorothalonil	3.2-4.3 WP	Begin before disease appears; repeat at 7-14-day intervals throughout the season.	
	Cycloheximide-Thiram (1:100)	WP, follow manufacturer's directions.	Disease can occur from April to August. Spray at 7-14-day intervals until disease is controlled.	
	Zineb	1.5 WP	Begin in early spring or before disease appears; repeat at 7-14-day intervals.	

Disease and Crop	Fungicide	Ounces of active ingredient to apply per 1,000 sq. ft. unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
Fairy rings and Mushrooms (*Marasmius* spp., *Psalliota campestris*, and *Lepiota* spp.) Most turfgrasses	None effective.		Replace infested soil.	For all chemicals on this page: Do not graze treated areas. Do not feed clippings to livestock.
Fusarium blight (*Fusarium roseum*) Bentgrasses Bluegrasses, especially Merion Kentucky. Fescues Ryegrass	Benomyl	2.4-4 WP	Apply as a drench when disease first appears; repeat 10-14 days later.	
	Fenarimol	1.0 WP	Begin 1 to 2 weeks prior to anticipated appearance; repeat every 30 days.	
	Iprodione	2 WP	Apply in late June; repeat when symptoms appear at 12-14-day intervals.	
	Mancozeb (turf formulation).	4-6 of WP formulation	April-September, every 7-10 days.	
	Thiophanate	2-4 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	
	Thiophanate-methyl	2.8-5.6 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	
	Triadimefon	0.5-1.0 WP	Apply 30 days prior to time this blight is normally evident. Apply at 15- or 30-day intervals depending on rate.	
Gray leaf spot (*Piricularia grisea*) St. Augustinegrass	Captan	1.6 WP	Begin when growth starts in spring; repeat at 7-14-day intervals throughout the season.	
	Chlorothalonil	3.2-4.3 WP	Begin before disease appears; repeat at 7-14-day intervals throughout the season.	

Disease and Crop	Fungicide	Ounces of active ingredient to apply per 1,000 sq. ft. unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
Gray leaf spot (*Piricularia grisea*) St. Augustinegrass (con.)	Folpet-Cadmium carbonate-Thiram (12:1:2)	WP, follow manufacturer's directions.	Apply as a drench from spring-fall, every 5-14 days during extended warm periods.	For all chemicals on this page: Do not graze treated areas. Do not feed clippings to livestock.
	Thiram	0.9 lb as a dust or 1.14 lb/25-50 gal/ 5,000 sq ft.		
	Zineb	3 WP	Begin before disease appears; repeat at 8-10-day intervals.	
Helminthosporium diseases: Melting-out (*H. vagans*) Kentucky bluegrass Zonate eyespot (*H. giganteum*) Tall fescue Bentgrasses Bluegrasses Bermudagrass Fescues Ryegrass Helminthosporium leaf spot (*H. sorokinianum*) Bentgrasses Bluegrasses Fescues Ryegrass Red leaf spot (*H. erythrospilum*) Bentgrasses	Anilazine	2-4 WP	During warm, humid weather, every 5-14 days.	
	Cadmium sebacate 5.0% Potassium chromate 5.0% Malachite green 1.0% Auramine 0.5% Thiram 16%	2-8 oz of WP product		
	Captan	1.6 WP	Begin when growth starts in spring; repeat at 7-14-day intervals throughout the season.	
	Chlorothalonil	2.1-4.3 WP	Begin in early spring and continue at 7-14-day intervals until summer.	
	Iprodione	1 WP	Begin when disease first appears; repeat as needed every 7-14 days.	
	Mancozeb (turf formulation).	4 of WP formulation	Begin when grass greens up in spring; repeat at 7-14-day intervals throughout the season.	
	Maneb	2.4-6.4 WP in sufficient water.	Begin when disease first appears; repeat at 7-14-day intervals.	
	Thiophanate	2-4 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	

Disease and Crop	Fungicide	Ounces of active ingredient to apply per 1,000 sq. ft. unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
Helminthosporium diseases: (con.) Helminthosporium blight (H. dictyoides) Fescues Ryegrass Brown blight (H. siccans) Fescues Ryegrass Leaf blotch (H. cynodontis) Bermudagrass Helminthosporium spp. Zoysiagrasses Centipedegrass	Thiram	2.5-3.5 WP	Begin in early spring; repeat at 7-10-day intervals while temperatures are between 45-80°F, and again in fall.	For all chemicals on this page: Do not graze treated areas. Do not feed clippings to livestock.
	Zineb	1.5 WP	Begin in early spring before disease appears; repeat at 7-14-day intervals.	
Pythium blight (Pythium aphanidermatum and P. ultimum) Bentgrasses Bluegrasses Ryegrass Bermudagrass Fescues Zoysiagrasses	Cadmium chloride	1 of 20.1% L formulation.	June-September, every 10-14 days.	
	Chloroneb	2.6 WP/3-5 gal water	Apply during periods of high temperature and humidity; repeat in 5-7 days if condition persists.	
	Etridiazole	1-3 of 40.7% L formulation.	Begin when disease appears. Retreat at 5-10-day intervals until disease is controlled.	Do not apply in combination with other pesticides or with nutrients.
	Fenaminosulf	1.4-1.8 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	
	Mancozeb (turf formulation).	6 of WP formulation	Begin at first sign of disease; repeat at 5-10-day intervals, more frequently under severe conditions.	
	Metalaxyl	0.25-0.50 L	Apply as a preventative treatment. Retreat at 10-21-day intervals until disease is controlled or as long as conditions favor disease development.	

Disease and Crop	Fungicide	Ounces of active ingredient to apply per 1,000 sq. ft. unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
Pythium blight (*Pythium aphanidermatum* and *P. ultimum*) Bentgrasses Bluegrasses Ryegrass Bermudagrass Fescues Zoysiagrasses (con.)	Propamocarb hydrochloride.	0.8-2.6 L	Apply as a preventative when conditions are conducive to disease. Repeat at 7-21-day intervals if conditions remain favorable for disease development.	For all chemicals on this page: Do not graze treated areas. Do not feed clippings to livestock.
	Zineb	1.0-1.5 WP	Begin before disease appears; repeat at 3-10-day intervals.	
Powdery mildew (*Erysiphe graminis*) Bermudagrass Bluegrasses Fescues	Cycloheximide-Thiram (1:100)	WP, follow manufacturer's directions.	When the disease is first evident in spring or early fall, apply at 10-day intervals.	
	Propiconazol	0.25-0.5 pint (1.8-3.6 oz a.i.) of 41.8% formulation per acre.	Apply when disease is first noticeable; repeat at 14-21-day intervals.	For use in seed production in Oregon, Washington, Idaho, and Minnesota only.
Red thread (*Corticium fuciforme*) Bentgrasses Bluegrasses Ryegrass Fescues	Cadmium chloride	1 of 20.1% L formulation.	May-June and August-September, every 10-14 days.	
	Cadmium sebacate 5.0% Potassium chromate 5.0% Malachite green 1.0% Auramine 0.5% Thiram 16%	2-8 of WP product		
	Cadmium succinate	0.3 WP	Begin when disease is first noticed; repeat at 1-week intervals until disease is controlled.	
	Chlorothalonil	3.2-4.3 WP	Begin before disease appears; repeat at 7-14-day intervals.	
	Cycloheximide-Thiram (1:100)	4 of WP formulation in 5 gal of water.		
	Folpet-Cadmium carbonate-Thiram (12:1:2)	WP, follow manufacturer's directions.		

Disease and Crop	Fungicide	Ounces of active ingredient to apply per 1,000 sq. ft. unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
Red thread (*Corticium fuciforme*) Bentgrasses Bluegrasses Ryegrass Fescues (con.)	Mancozeb (turf formulation).	4-6 of WP formulation		For all chemicals on this page: Do not graze treated areas. Do not feed clippings to livestock.
	Thiophanate	1 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	
	Thiophanate-methyl	1 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	
Rust (*Puccinia* spp.) Bluegrasses, especially Merion Kentucky. Zoysiagrasses	Anilazine	2-4 WP	During warm, humid weather, every 5-14 days.	
	Chlorothalonil	3.2-4.3 WP	Treat every 7-14 days until rust disappears.	For bluegrass only.
	Cycloheximide-Thiram (1:100)	WP, follow manufacturer's directions.	June-September, every 7-14 days.	
	Mancozeb (turf formulation).	4-6 WP of formulation		
	Maneb	2.2-6.4 WP in sufficient water.	Begin when rust pustules first appear; repeat at 7-14-day intervals.	
	Propiconazol	0.25-0.5 pint (1.8-3.6 oz a.i.) of 41.8% formulation per acre.	Apply when disease first appears; repeat at 14-21-day intervals.	For use in seed production in Oregon, Washington, Idaho, and Minnesota, only.
	Zineb	1.0-1.5 WP	Begin when disease first appears; repeat at 10-14-day intervals.	
Slime molds (non-parasitic *Myxomycete* spp.) Most turfgrasses	Zineb	1.5 WP	During periods of wet or humid weather when slime molds occur.	May be dispersed mechanically by brushing, mowing, or spraying with strong stream of water.

Disease and Crop	Fungicide	Ounces of active ingredient to apply per 1,000 sq. ft. unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
Snow molds (Typhula spp.) and Fusarium patch (Fusarium nivale) Bentgrasses Bluegrasses Bermudagrass Ryegrass Fescues				For all chemicals on this page: Do not graze treated areas. Do not feed clippings to livestock.
	Benomyl	1 WP	Apply as a drench when disease first appears; repeat at 10-14-day intervals as needed.	For Fusarium only.
	Cadmium succinate	1.2-2.4 WP	Apply in late fall before ground freezes and before first residual snow cover is expected; repeat during midwinter thaw.	Not effective against Fusarium.
	Chloroneb	3.90-5.85 WP in sufficient water for thorough coverage.	Apply as late in fall as possible before snowfall; repeat in midwinter if turf is free of snow, and in late winter as snow melts.	For Typhula only.
	Fenarimol	1-2 WP	Apply in late fall prior to turf dormancy. Re-apply during period of thawing.	
	Thiabendazole	0.5-1.2 WP	Apply as late in fall as possible before snowfall; repeat in midwinter if turf is free of snow and in late winter as snow melts.	For Fusarium only.
	Thiophanate-methyl	1 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	
	Triadimefon	1-2 WP	Apply in late fall prior to turf dormancy. Re-apply during period of thawing.	
	Vinclozolin	1-2 WP	Begin when disease is first noticed; repeat in 1-3 weeks while disease conditions prevail.	For Fusarium only.

Disease and Crop	Fungicide	Ounces of active ingredient to apply per 1,000 sq. ft. unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
				For all chemicals on this page: Do not graze treated areas. Do not feed clippings to livestock.
Stripe smut (Ustilago striiformis) Bentgrasses Bluegrasses, especially Merion Kentucky. Meadow fescue Redtop Ryegrass	Benomyl	3 WP/2-5 gal water	Apply in October or early spring before grass begins growth. After treatment, water turf sufficiently to carry product to base of plants.	
	Fenarimol	2 WP	Make a single application in October or in early spring prior to greening.	
	Thiophanate	2 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	
	Thiophanate-methyl	2.8-5.6 WP	Begin when disease first appears. Treat every 5-10 days until disease is controlled.	
	Triadimefon	0.5-1.0 WP	0.5-oz rate in spring, 1-oz rate in fall.	

VEGETABLE DISEASES

by

Philip D. Dukes

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Soon after the monumental works of W.A. Orton in breeding disease-resistant (wilt-resistant) plants in the early 1900's, host resistance received rapidly increasing attention in Europe and the United States. Breeding for host resistance has continued to be a major means of controlling diseases, and today many important diseases of numerous economic crops, including vegetables, carry resistance to some diseases.

The use of disease-resistant varieties of vegetables should be considered carefully in any disease-control program, regardless of the amount of the vegetable to be grown (that is, a few plants or many acres). A vegetable variety sometimes can be selected with some degree of resistance, which will reduce the amount of chemical control required, even under severe disease pressure. The greatest need for resistant varieties is in situations that do not lend themselves to other remedial measures. Unfortunately, resistant varieties often are unavailable, and sometimes no sources of resistance have been found. Thus, a wise disease-control program should consist of an integrated approach that would include chemicals, host resistance (when available), crop management, and any other methods coupled with control of pests other than diseases.

It is impossible to list in this publication all varieties of vegetable crops that have resistance to one or more plant diseases. In the table of vegetable diseases, however, the availability of a resistant variety or varieties is footnoted by the specific disease for a particular crop. Interested persons should contact their local extension service or other agricultural agencies for specific information on resistant varieties suitable for their locality.

Host resistance, for example, is relied upon as the major method of control for the following diseases of vegetable crops:

1. Fusarium wilts of tomato, sweetpotato, watermelon, blackeye pea, pea, and muskmelon
2. Cabbage yellows
3. Common mosaic of bean
4. Clubroot of turnip and rutabaga
5. Onion smudge
6. Cucumber mosaic
7. Black wart of potato
8. Internal cork of sweetpotato
9. Southern bacterial wilt of eggplant.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ARTICHOKE (globe and Jerusalem)					
Leaf spots	Sulfur, dust	NTL*	22-37 lb/acre	Dust at first appearance of leaf spots.	Avoid hot days—may burn the foliage.
ASPARAGUS					
Rust ** (*Puccinia asparagi*)	Mancozeb	—***	1.6 lb/acre	Apply to ferns. Spray first at appearance of rust, then at 7-10-day intervals as necessary.	Use only on ferns after spears have been harvested.
	Maneb	—***	1.6-2.4 lb/acre	Same as above.	
	NIA 9102	—***	1.6-2.4 lb/50 gal/acre.	Same as above.	
	Sulfur	NTL*	6-35 lb/acre	Apply only to ferns. Treat at first appearance of rust; continue at 7-10-day intervals.	See label.
Botrytis root rot and Fusarium root rot	Captan	—***	1.5 lb/100 gal	Preplanting root dip. Dip for one minute, drain, and plant.	
Crown rot	Mancozeb	—***	0.8 lb/100 gal	Dip crowns for 5 minutes; plant crowns as soon as possible.	See label for planting stock.
BEAN, LIMA					
Downy mildew ** (*Phytophthora phaseoli*) and Stem anthracnose (*Colletotrichum truncatum*)	Maneb	4	1.2-1.6 lb/100 gal		
	Zineb	7	0.75-1.5 lb/acre	Apply at first appearance of disease and at 7-10-day intervals.	Do not feed treated forage or hay to livestock.
Powdery mildew (*Erysiphe polygoni*)	Sulfur	NTL*	4-7.8 lb/100 gal 3.8-36 lb/acre	Apply at first appearance of disease, then at 7-10-day intervals.	Sulfur may injure some varieties; see label.

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* No time limit.
** Resistant or tolerant varieties are available.
*** Does not apply.

VEGETABLE DISEASES

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
BEAN, SNAP, POLE					
Anthracnose * (Colletotrichum lindemuthianum)	Maneb	4	1.2-1.6 lb/100 gal 1.1-3.2 lb/acre	Begin when plants are small; repeat at 5-7-day intervals as necessary.	Plant disease-free seed; rotate. Do not feed treated plants to livestock.
	Zineb	7	0.7-1.5 lb/100 gal 0.6-3.0 lb/acre	Begin when disease threatens or after first blooms appear; repeat at 4-10-day intervals.	Same as above.
	Ziram	4	2.38 lb/100 gal 1.9-3.0 lb/acre	Apply before disease is expected, or at the very first sign of infection; repeat at 4-7-day intervals.	Same as above.
Rust * (Uromyces phaseoli)	Chlorothalonil	7	2.25 lb/acre	Apply at early bloom stage or when disease first threatens; repeat at weekly intervals or as necessary.	
	Maneb	4 Dry beans, NTL**	1.2-1.6 lb/100 gal 1.1-3.2 lb/acre	Apply at first appearance of disease; repeat at 5-7-day intervals.	Dry beans exempted from minimum days from last application to harvest.
	Zineb	7	0.7-1.6 lb/100 gal 0.6-1.5 lb/acre	Begin application when disease threatens or after first blooms appear; then at 4-10-day intervals as necessary.	
	Ziram	4	2.38 lb/100 gal 1.9-3.0 lb/acre	Begin before disease is expected to appear or at the [illegible] first sign of infection; repeat at 4-7-day intervals.	
White rot or Sclerotinia wilt (Sclerotinia sclerotiorum)	Benomyl	14	0.75-1.0 lb/acre	Apply first treatment at 25 to 50% bloom; repeat at peak of bloom.	Do not feed or allow livestock to graze treated plants. Ground equipment only.
	DCNA	2	(pole) 3 lb/100 gal (pole) 3.0 lb/acre (bush) 2.25 lb/acre	Apply first treatment when disease is anticipated; repeat at 7-day intervals as necessary.	Do not feed treated forage to livestock.
	PCNB	NTL**	2 lb/15 to 20 gal/ 8,400 ft See manufacturer's label.	In-furrow band spray at planting.	Do not feed treated forage to livestock. Do not apply after first bloom.
	Ziram	4	0.75-1.25 lb/100 gal 3 lb/acre	Begin before disease is expected to appear or at first sign of infection; repeat at weekly intervals.	For use in Pacific Northwest only.

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* Resistant or tolerant varieties are available.

** No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
BEAN, SNAP, POLE					
Powdery mildew * (*Erysiphe polygoni*)	Sulfur	NTL**	4-7.8 lb/100 gal See label. 50% Dust 40-50 lb/acre	Begin application when first true leaves form or at 7-10-day intervals.	Sulfur may injure certain varieties of beans; see local agricultural authorities.
Bacterial blight * (*Xanthomonas phaseoli*) and Halo blight * (*Pseudomonas phaseolicola*)	Fixed copper (copper oxide)	NTL**	1.08 lb/acre	Apply as a protective treatment when plants are 6 in high; repeat at 7-10-day intervals through harvest.	
Seed decay and Damping-off	(See seed treatment lists—captan, chloroneb, fenaminosulf, maneb, thiram, and zineb.)				
BEET, TABLE					
Leaf spot * (*Cercospora beticola*)	Zineb	7 if tops are to be consumed.	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre	Begin when disease first appears; repeat at 7-10-day intervals as needed.	
Rust (*Uromyces betae* and *Puccinia aristidae*), Downy mildew *** (*Peronospora schachtii*), and Leaf spots, several pathogens.	Sulfur	NTL**	See label. 15-20 lb/acre	Apply at first appearance of disease; repeat at 7-10-day intervals as needed.	
	Zineb	7	See label. 0.75-1.5 lb/acre	Same as above.	
Seed decay and Damping-off, various causes.	(See seed treatment lists—captan, dichlone, fenaminosulf, thiram, and zineb.)				

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* Resistant or tolerant varieties are available.
** No time limit.
*** Obtain seed from disease-free areas if possible.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
BROCCOLI, BRUSSELS SPROUTS, CABBAGE, CAULIFLOWER					
Alternaria leaf spot (*Alternaria brassicae*) and Downy mildew * (*Peronospora parasitica*)	Chlorothalonil	NTL**	1.125 lb/acre	Spray at first appearance of disease, and continue at 7-10-day intervals. Use spreader-sticker for maneb and zineb.	Chlorothalonil is to be used for Alternaria leaf spot in Southeastern States only.
	Maneb	7	0.8-2.4 lb/acre (all but cabbage) 0.8-1.8 lb/acre (cabbage only)	Same as above.	Exclusion: Maneb has 7-day waiting period in cabbage only. Remove residues by washing or trimming if application is made within 3 days of harvest.
	Zineb	7	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre	Same as above.	
Powdery mildew (*Erysiphe polygoni*)	Sulfur	NTL**	6-25 lb/acre	Apply at first appearance of disease; continue at 7-10-day intervals.	
Clubroot *** (*Plasmodiophora brassicae*)	(Hydrated lime) + PCNB	 —****	1500 lb/acre 4.5 lb/100 gal 0.75 pint/plant	Broadcast and work lime in soil by disking 0-3 days before planting. In transplant water.	
Wire stem or Black root (*Rhizoctonia solani*)	PCNB	—****	4.5 lb/100 gal 0.75 pint/plant	In transplant water.	
Seed decay and Damping-off	(See seed treatment lists—captan and thiram.)				
BRUSSELS SPROUTS	(See Broccoli, Brussels sprouts, Cabbage, Cauliflower.)				

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* Some resistant or tolerant varieties of broccoli and cauliflower may be available.
** No time limit.
*** Resistant or tolerant varieties are available.
**** Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CABBAGE	(See Broccoli, Brussels sprouts, Cabbage, Cauliflower.)				
CANTALOUP, WATERMELON, PUMPKIN, AND SQUASH Downy mildew * (*Pseudoperonospora cubensis*) and Anthracnose * (*Colletotrichum lagenarium*)	Benomyl (anthracnose only)	NTL**	0.12-0.25 lb/acre	Apply at first appearance of disease; repeat at 7-14-day intervals.	Use western-grown seed. It is best to alternate fungicides. Alternate benomyl with chlorothalonil and other fungicides. Use benomyl only for anthracnose, or combinations for both diseases.
	Captafol	NTL**	1.2-2.5 lb/acre	Apply when first true leaves appear; repeat at weekly intervals.	Not registered for use on pumpkin or squash.
	Chlorothalonil	NTL**	1.125-1.5 lb/acre	Begin when plants are in first true leaf stage or when conditions favor disease development; repeat at 7-day intervals, more frequently under severe disease conditions.	
	Bordeaux mixture Copper oxychloride sulfate Fixed copper (basic copper sulfate)	NTL**	See label.	Apply at first appearance of disease; repeat at 7-14-day intervals.	Repeated use of copper may cause leaf yellowing.
	Mancozeb	5	1.6 lb/acre	Same as above.	
	Maneb	5	1.2-1.6 lb/100 gal 1.2-2.8 lb/acre	Begin when disease threatens or plants begin to form runners; repeat at 7-10-day intervals or more frequently under severe disease conditions.	
	Maneb-zinc	5	1.6-2.4 lb/acre	Begin in 2-leaf stage; repeat at 5-7-day intervals.	
	NIA 9102	5	1.6 lb/100 gal 1.6 lb/acre	Begin application at first appearance of disease and continue every 7 days as necessary.	Not registered for use on watermelon, pumpkin, or squash.
	Zineb	5	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre	Begin when plants emerge or develop runners, or when disease appears.	

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* Resistant varieties of cantaloup and watermelon are available.

** No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CANTALOUP, WATERMELON, PUMPKIN, AND SQUASH					Use western-grown seed. It is best to alternate fungicides.
Powdery mildew * (*Erysiphe cichoracearum* and *Sphaerotheca fuliginea*)	Benomyl	NTL**	0.12-0.25 lb/acre	Apply at first appearance of disease; repeat at 7-14-day intervals.	Alternate these fungicides; continue every 7-14 days until disease is no longer a problem. Do not use chlorothalonil for powdery mildew in Southwestern States.
	Chlorothalonil	NTL**	1.5 lb/acre	Same as above.	
	Dinocap	7	0.2-0.4 lb/acre	Apply at first appearance of disease; repeat every 7-14 days.	
Gummy stem blight *** or Mycosphaerella black rot (*Mycosphaerella citrullina*)	Benomyl	NTL**	0.12-0.25 lb/acre	Apply at first appearance of disease; repeat at 7-14-day intervals.	Alternate benomyl with chlorothalonil and other fungicides.
	Captafol	NTL**	1.2-2.5 lb/acre	Apply when first true leaves appear; repeat at weekly intervals.	Not registered for use on pumpkin or squash.
	Chlorothalonil	NTL**	1.125-1.5 lb/acre	Begin when plants are in first true leaf stage or when conditions favor disease development; repeat at 7-day intervals, more frequently under severe disease conditions.	
	Copper oxychloride sulfate Fixed copper (basic copper sulfate)	NTL**	See label.	Apply at first appearance of disease; repeat at 7-14-day intervals.	Repeated use of copper may cause leaf yellowing.
	Mancozeb	5	1.6 lb/acre	Same as above.	
	Maneb	5	1.2-1.6 lb/100 gal 1.2-2.8 lb/acre	Begin when disease threatens or plants begin to form runners; repeat at 7-10-day intervals or more frequently under severe disease conditions.	
	Maneb-zinc	5	1.6-2.4 lb/acre	Begin in 2-leaf stage; repeat at 5-7-day intervals.	
	NIA 9102	5	1.6 lb/100 gal 1.6 lb/acre	Begin application at first appearance of disease and continue every 7 days as necessary.	Not registered for use on watermelon, pumpkin, or squash.
	Zineb	5	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre	Begin when plants emerge or develop runners, or when disease appears.	
Seed decay and Damping-off	(See seed treatment lists--captan, thiram, and zineb.)				

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* Resistant varieties of cantaloup are available.
** No time limit.
*** Some resistant varieties of cantaloup are available.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CARROT					
Cercospora leaf spot * (Cercospora carotae) and Alternaria leaf blight (Alternaria dauci)	Chlorothalonil	NTL**	1.1-1.5 lb/acre	Apply at first appearance of disease; repeat at 7-10-day intervals.	
	Fentin hydroxide	14	1.9-3.2 lb/acre	Same as above.	Do not feed treated tops to livestock.
	Mancozeb	7	1.2-1.6 lb/acre	Same as above.	Do not use treated tops for food or feed.
	Maneb	NTL**	1.2-1.6 lb/100 gal 0.8-3.0 lb/acre	Apply at first appearance of disease; repeat at 7-10-day intervals as necessary.	
	Maneb-zinc	7	1.5 lb/acre	Same as above.	
	Zineb	7 if tops are to be consumed.	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre	Same as above.	
Southern blight (Sclerotium rolfsii)	DD-MENCS	—***	6-8 gal/acre	Fumigate soil; see label.	Treat soil 3-6 weeks, or longer if soil is cold, before seeding.
Seed decay and Damping-off	(See seed treatment lists—captan and thiram.)				
CAULIFLOWER	(See Broccoli, Brussels sprouts, Cabbage, Cauliflower.)				
CELERY					
Bacterial blight (Pseudomonas apii)	Copper-ammonium complex Copper hydroxide Copper oxychloride sulfate Copper sulfate (monohydrate)	NTL**	See manufacturer's label.	Treat at first appearance of disease.	Use clean seed.
	Streptomycin sulfate	Transplant beds only.	50-200 p/m as a spray.	Begin when seedlings are in 2-leaf stage; repeat at 4-5-day intervals until transplanted.	Transplant beds only.

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* Resistant varieties have been reported.

** No time limit.

*** Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CELERY					
Early blight * (*Cercospora apii*) and Late blight * (*Septoria apii* and *S. apii-graveolentis*)	Anilazine	NTL**	1.0 lb/100 gal 1.0 lb/acre	For all chemicals: Apply treatment at first appearance of disease; repeat at 7-10-day intervals as necessary. Clean, disease-free seed should be used.	For all chemicals: Remove excess residues by stripping, trimming, and washing.
	Benomyl	7	0.125-0.25 lb/acre		
	Chlorothalonil	7	1.5-2.25 lb/acre		
	Bordeaux mixture Copper ammonium carbonate Copper-ammonium complex Copper hydroxide Copper oxychloride sulfate Copper sulfate (monohydrate) Copper-zinc sulfate complex Fixed copper (basic copper sulfate, copper oxide, copper oxychloride)	NTL**	See labels.		
	Mancozeb	14	1.6 lb/acre		
	Maneb	14	1.2-1.6 lb/100 gal 1.75-2.8 lb/acre		
	NIA 9102	14	1.6/100-150 gal 1.6 lb/acre		
Damping-off (in plant bed)	Anilazine	NTL**	1.0 lb/acre	Apply as a spray or drench at first appearance of disease; continue as needed.	Plant bed treatment.
	Ferbam	NTL**	0.75-1.5 lb/acre	Same as above.	Plant bed treatment.
Pink rot (*Sclerotinia sclerotiorum*)	DCNA	7	1.5 lb/100 gal 1.5 lb/acre	Treat at first appearance of disease; continue at 5-10-day intervals.	
COLLARDS					
Powdery mildew (*Erysiphe polygoni*)	Sulfur, spray or dust	NTL**	See label. 6-25 lb dust/acre	Dust at first appearance of disease; repeat at 7-10-day intervals.	
Leaf spots (*Alternaria brassicae*) and Downy mildew (*Peronospora parasitica*)	Maneb	10	0.8-2.4 lb/acre	Treat at first appearance of disease; repeat at 7-10-day intervals. Use a spreader-sticker.	Remove residues by washing.
	Zineb	7	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre	Same as above.	

* Resistant varieties have been reported.

** No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
COLLARDS					
Seed decay and Damping-off	(See seed treatment lists—captan and thiram.)				
CORN	(See Sweet Corn.)				
COWPEA	(See Pea, Blackeye.)				
CUCUMBER					
Downy mildew * (*Pseudoperonospora cubensis*), Anthracnose * (*Colletotrichum lagenarium*), Alternaria leaf spot * (*Alternaria cucumerina*), Cercospora leaf spot (*Cercospora cucurbitae*), Gummy stem blight * or Black rot (*Mycosphaerella citrullina*), Scab * (*Cladosporium cucumerinum*), and Target leaf spot * (*Corynespora melonis*)	Benomyl	NTL**	0.12-0.25 lb/acre	For all chemicals: Apply treatment at very first appearance of disease; repeat at 7-14-day intervals as necessary. Shorter intervals between treatments may be required under severe disease conditions; this will depend on local conditions and disease pressure.	Exclusions: Benomyl--Downy mildew, Alternaria leaf spot, Cercospora leaf spot, scab. Captafol--Cercospora leaf spot. Chlorothalonil--Cercospora leaf spot. Maneb--Cercospora leaf spot, scab. NIA 9102--Anthracnose, Cercospora leaf spot, target leaf spot, scab. Caution: Copper may cause leaf yellowing with repeated applications.
	Captafol	NTL**	1.2-1.5 lb/acre		
	Chlorothalonil	NTL**	1.125-2.25 lb/acre		
	(various copper-containing compounds) No one copper compound is registered for all of these diseases, but one to several are registered for each individual disease.	NTL**	See manufacturer's label.		
	Mancozeb	5	1.6-2.4 lb/acre		
	Maneb	5	1.2-1.6 lb/100 gal 1.2-2.8 lb/acre		
	NIA 9102	5	1.6 lb/100 gal 1.6 lb/acre		
	Zineb	5	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre		
Angular leaf spot * (*Pseudomonas lachrymans*)	Bordeaux mixture Copper ammonium carbonate Copper-ammonium complex Copper hydroxide Copper oxychloride sulfate Copper salts of fatty and rosin acids Fixed copper (copper oxide, copper oxychloride)	NTL**	See label.	Apply treatment at first appearance of disease, then alternate with anthracnose schedule.	Repeated applications of copper fungicides may cause leaf yellowing.

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* Resistant varieties are available.

** No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
CUCUMBER					
Bacterial wilt * (*Erwinia tracheiphila*)	Apply insecticides to control the cucumber beetle that spreads the disease. Use resistant varieties.				
Powdery mildew * (*Erysiphe cichoracearum* and *Sphaerotheca fuliginea*)	Benomyl	NTL**	0.125-0.25 lb/acre	Apply treatment at first appearance of disease; repeat at 7-14-day intervals.	
	Chlorothalonil	NTL**	1.5-2.2 lb/acre	Same as above.	
	Sulfur, spray or dust.	NTL**	See label. 6-25 lb dust/acre	Same as above.	Avoid hot days and sensitive varieties when sulfur is to be used.
Fruit (belly) rot (*Rhizoctonia solani*) and other pathogens	Captafol	NTL**	3.0/50 gal per acre	Apply after last cultivation or when vines begin to spread. Direct material to bed soil and do not disturb after application.	Southeastern States only for captafol.
	Chlorothalonil	NTL**	2.25 lb/acre		
	Folpet	NTL**	3.0-4.0 lb/acre		
EGGPLANT					
Damping-off, in plant bed (Several soilborne pathogens).	Captan	—***	0.5-3 lb/100 gal 2.5 gal/100 sq ft	Drench after seeding, at emergence, or when disease first appears.	
Leaf blights and fruit rots, which include: Anthracnose (*Colletotrichum* spp. and *Gloeosporium* spp.), Phomopsis blight * (*Phomopsis vexans*), and Early blight (*Alternaria solani*)	Captan	NTL**	1.0 lb/100 gal See label.	For all fungicides: Begin treatment at first appearance of disease, or as fruit ripens; repeat at 7-10-day intervals.	
	Maneb	NTL**	1.2-1.6 lb/100 gal 1.1-2.8 lb/acre		
	Zineb	NTL**	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre		
	Ziram	NTL**	1.14-1.52 lb/100 gal		
Powdery mildew (*Erysiphe cichoracearum*)	Sulfur	NTL**	See label. 7-35 lb/acre	Apply at first appearance of disease; repeat at 7-10-day intervals as needed.	
Verticillium wilt * (*Verticillium albo-atrum*)	Use resistant varieties where possible.				
Bacterial wilt * (*Pseudomonas solanacearum*)	Use resistant varieties where possible.				
Seed decay and Damping-off	(See seed treatment lists—captan and thiram.)				

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* Resistant varieties are available.
** No time limit.
*** Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ENDIVE-ESCAROLE					
Downy mildew (*Bremia lactucae*)	Maneb	10	1.2-1.6 lb/100 gal 1.3-3.2 lb/acre	Treat at first appearance of disease; repeat at 7-10-day intervals.	Remove residues by trimming and washing.
	Zineb	10	0.75-1.5 lb/acre	Same as above.	
GARLIC	(See Onion and Garlic.)				
KALE					
Alternaria leaf spot (*Alternaria brassicae*) and Downy mildew (*Peronospora parasitica*)	Maneb	10	0.8-2.4 lb/acre	Apply when plants emerge or at first appearance of disease; repeat as necessary.	
	Zineb	10	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre	Same as above.	
Powdery mildew (*Erysiphe polygoni*)	Sulfur	NTL*	See label. 6-25 lb/acre	Apply at first appearance of disease; repeat at 7-10-day intervals.	
Seed decay and Damping-off	(See seed treatment lists—captan and thiram.)				
KOHLRABI					
Powdery mildew (*Erysiphe polygoni*)	Sulfur	NTL*	See label. 6-25 lb/acre	Apply treatment at first appearance of disease; repeat at 7-10-day intervals as needed.	
Alternaria leaf spot (*Alternaria brassicae*) and Downy mildew (*Peronospora parasitica*)	Maneb	NTL*	1.2 lb/100 gal Up to 2.6 lb/acre	Begin when disease threatens; repeat at 3-day intervals in plant beds, and at 7-10-day intervals in field.	
	Zineb	See restrictions	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre	Begin when plants emerge; repeat as necessary.	Do not apply after edible parts are half grown.
Seed decay and Damping-off	(See seed treatment list--thiram.)				
LETTUCE					
Downy mildew ** (*Bremia lactucae*)	Maneb	10	1.2-1.6 lb/100 gal 1.3-3.2 lb/acre	Begin treatment when disease first appears; repeat at 7-10-day intervals as necessary.	Remove residues by trimming and washing.
	Zineb	10	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre	Begin treatment when plants emerge; repeat treatment as required.	

USE PESTICIDES SAFELY — READ THE LABEL

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* No time limit.

** Resistant varieties are available.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
LETTUCE					
Gray mold or Botrytis slime (*Botrytis cinerea*)	Zineb	10	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre	Begin application in plant bed as a drench; repeat as necessary. In the field, treat at 7-10-day intervals.	
Damping-off, in plant bed	Ferbam	--*	0.4-0.7 lb 100 gal	Drench or heavy spray application as soon as plants are up; repeat at 2-week intervals.	Apply only to plant beds.
Powdery mildew (*Erysiphe cichoracearum*)	Sulfur	NTL**	See label. 10-15 lb/acre	Apply treatment at first appearance of disease; repeat at 7-10-day intervals.	
Drop (*Sclerotinia sclerotiorum*)	DCNA	14	2.0 lb/acre	Apply treatment at first appearance of disease; repeat at 7-10-day intervals.	
Seed decay and Damping-off	(See seed treatment lists—dichlone and thiram.)				
MELONS	(See Cantaloup, Watermelon, Pumpkin, and Squash.)				
MUSHROOMS					
Brown spot, Dry bubble, or Verticillium spot (*Verticillium malthousei*) and Green mold (*Trichoderma* sp.)	Benomyl	2	0.5 lb/100 gal 0.25 lb/4,000 sq ft	Begin soon after casing soil is applied; repeat at 3-7-day intervals until small buttons begin to form, then apply to casing soil between "breaks."	For brown spot.
Mycogone or Wet bubble (*Mycogone perniciosa magnus*)			0.125-0.25 lb/4,000 sq ft as a drench.		
Soft mildew or Cobweb (*Dactylium dendroides*, conidial stage of *Hypomyces vosellus*)	Zineb		0.75 lb/100 gal using 10.0 gal of spray/4,000 sq ft 0.07-0.15 lb as a dust/4,000 sq ft.	Same as above.	

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* Does not apply.
** No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
MUSHROOM CASING SOIL					
Fungi	Chloropicrin	—*	5-10 cc/cu ft (0.5 to 1.0 lb actual/cu yard).	Water surface after treatment and cover with plastic or wet newspaper for 24 hours.	
MUSTARD AND TURNIP GREENS					
Powdery mildew (*Erysiphe polygoni*)	Sulfur	10	See label. 6-25 lb/acre	Treat at first appearance of disease; repeat at 7-10-day intervals.	Remove residues by washing. Practice crop rotation. Plant treated seed.
Anthracnose (*Colletotrichum higginsianum*), Cercospora leaf spot (*Cercospora brassicicola*), and White leaf spot (*Cercosporella brassicae*)	Maneb	10	0.8-2.4 lb/acre	Begin application when plants are up to a stand where disease has been a problem, or at first sign of disease in other areas; repeat treatment every 7 days.	
	Zineb	7 turnip 10 mustard	0.75-1.5 lb/acre	Same as above.	
Downy mildew (*Peronospora parasitica*) and Alternaria leaf spot (*Alternaria brassicae*)	Maneb	10	0.8-2.4 lb/acre	Begin treatment when disease first appears; repeat at 7-10-day intervals.	Remove residues by washing.
	Zineb	7 turmip 10 mustard	0.65-1.5 lb/100 gal 0.6-3.0 lb/acre	Same as above.	Hot water seed treatment and crop rotation are important control practices.
Seed decay and Damping-off	(See seed treatment lists—captan and thiram.)				
OKRA					
Verticillium wilt (*Verticillium albo-atrum*)	DD-MENCS	—*	5-8 gal/acre	Soil fumigation. Fumigate soil in the row 3-6 weeks before seeding.	Use material according to manufacturer's directions. Wilt is often a very serious disease of okra. Control nematodes and practice crop rotation.
Seed decay and Damping-off	(See seed treatment list--thiram (especially important for this crop.)				

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* Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
ONION AND GARLIC					
Downy mildew (Peronospora destructor), Purple blotch ** (Alternaria porri), and Botrytis blight or Leaf blast ** (Botrytis spp.)	Anilazine	NTL*	1.5 lb/acre	Begin treatment at first appearance of disease; repeat at 7-10-day intervals.	Do not use anilazine for downy mildew.
	Captafol	NTL*	1.25 lb/acre	Same as above.	
	Mancozeb	7 dry bulb	1.6-2.4 lb/100 gal 1.6-2.4 lb/acre	Same as above.	For dry bulb onions.
	Maneb	NTL*	1.2-1.6 lb/100 gal 1.75-2.8 lb/acre	Same as above.	For onion only.
	Zineb	7-green	0.75-1.5 lb/100 gal 0.6-3.0 lb/acre	Same as above.	For onion only. Use a spreader-sticker.
White rot (Sclerotium cepivorum)	DCNA	--***	24-30 lb/100 gal 15-24 lb/acre	Apply to soil as a spray and mix 1.5 in deep 2 weeks before seeding.	Soil treatment—see label. Do not plant spinach as a followup crop in treated soil. Rates may vary for some locations.
	DD-MENCS	--***	35 gal/acre	Broadcast fumigant 3-6 weeks before seeding or setting.	See label.
Smut **** (Urocystis cepulae)	Captan (green and bulb preharvest)	NTL*	See label. 1.12 lb/acre	Onion only--in mineral soil, furrows spaced 18 in apart.	See label for restrictions on amounts for foliar and soil applications in various regions and under different soil conditions.
			2.0 lb/acre	In muck soil, furrows spaced 18 in apart. Begin treatment at first sign of disease; repeat at 7-10-day intervals.	
Seed decay and Damping-off	(See seed treatment lists—captan, HCB, and thiram.)				
PEA, BLACKEYE (Southern pea or blackeye bean)					
Fusarium wilt ** (Fusarium oxysporum f. sp. tracheiphilum)	(Select resistant varieties where possible. Three races of the pathogen have been reported—there is host resistance to all races.)				
Powdery mildew (Erysiphe polygoni and Microsphaera alni)	Sulfur	NTL*	See label. 5-25 lb/acre	Dust at first appearance of disease; repeat at 7-10-day intervals as necessary.	
Root rot (several pathogens)	Captan	--***	3.5-6.0 lb/acre	Incorporate dust to a depth of 2 to 4 in; preplant for broadcast treatment.	
			3.0 lb/acre	At planting for row treatment.	

* No time limit.
** Some resistant varieties are available.
*** Does not apply.
**** Resistant varieties have been reported.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PEA, BLACKEYE (Southern pea or blackeye bean)					
Seed decay and Damping-off	(See seed treatment lists—captan, thiram, and zineb.)				
PEA, GARDEN AND FIELD (ENGLISH) Anthracnose (*Colletotrichum pisi*), Downy mildew * (*Peronospora pisi*), Rust (*Uromyces fabae*) and Other leaf spots	Zineb	10	1.0-2.0 lb/acre	Begin treatment at first appearance of disease; repeat at 7-14-day intervals as necessary.	
Powdery mildew * (*Erysiphe polygoni*)	Sulfur (wettable)	NTL**	4.0-7.8 lb/acre	Apply spray treatment at first appearance of disease; repeat at 7-14-day intervals.	Select clean seed from areas where disease does not occur. Do not use on hot days (90°F) or apply when plants are wet.
Seedling blights, Seed decay, and Damping-off (*Aphanomyces* and *Pythium* spp.)	(See seed treatment lists—captan, dichlone, fenaminosulf, maneb, thiram, and zineb.)				
PEPPER					
Blue mold or Downy mildew (*Peronospora tabacina*), Anthracnose (*Colletotrichum capsici*, *Gloeosporium piperatum*, and *Glomerella cingulata*), and Frogeye spot (*Cercospora capsici*)	Captan	NTL**	1.5 lb/100 gal	Begin treatment at very first sign of disease; repeat at 7-10-day intervals.	
	Ferbam	—***	0.76-1.14 lb/100 gal 0.76-1.14 lb/acre	Plant bed treatment. Begin at first sign of disease; continue at 7-10-day intervals.	Plant bed treatment only.
	Maneb	NTL**	1.2-1.6 lb/100 gal 1.05-2.8 lb/acre	Begin treatment at very first sign of disease; repeat at 7-10-day intervals.	Do not use for blue mold.
	Zineb	NTL**	0.75-1.5 lb/100 gal 0.6-3.0 lb/acre	Same as above.	
Powdery mildew (*Erysiphe cichoracearum*)	Sulfur	See label.	7-37 lb/acre	Treat at first appearance of disease; repeat at 7-10-day intervals.	
Blossom end rot (physiological disease)	Calcium chloride	NTL**	3 lb/acre	Begin treatment at first sign of disease and make 3 applications at 7-day intervals. (Can be purchased at many tractor tire dealers.)	

* Resistant varieties have been reported.
** No time limit.
*** Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PEPPER					
Bacterial spot (*Xanthomonas vesicatoria*) Plant bed	Copper ammonium carbonate Copper-ammonium complex Copper hydroxide Copper oxychloride sulfate Copper salts of fatty and rosin acids. or Fixed copper (basic copper sulfate, copper oxide)	—*	See label.	Begin treatment immediately after first appearance of disease; repeat at 7-10-day intervals before transplanting. Use spreader-sticker.	
	Streptomycin sulfate	—*	0.17 lb/acre (200 p/m)	Same as above.	Plant bed treatment only.
Field	Maneb-zinc + one of the following: Copper ammonium carbonate Copper-ammonium complex Copper hydroxide Copper oxychloride sulfate Copper salts of fatty and rosin acids. or Fixed copper (basic copper sulfate, copper oxide) (48-53% metallic Cu).	NTL**	See label. 1.2 lb/acre + copper (see label)	Begin application immediately at first sign of disease; repeat at 7-10-day intervals. Severe disease pressure may require shorter intervals.	
Damping-off (Plant beds)	Captan	—*	0.5 lb/100 gal 2.5 gal/100 sq ft	Drench or apply a heavy spray after seeding or at first appearance of disease; repeat at 7-10-day intervals.	
	Zineb	—*	1.5 lb/100 gal 0.5 gal/sq yard		
Southern blight (*Sclerotium rolfsii*)	PCNB	—*	3-5 lb/100 gal 2.25-3.75 lb/acre	Use 0.5 pt per plant when transplanting.	Rotate with corn or other grasses. Deep plow to bury crop residues.
	PCNB	—*	See label. 7-7.5 lb per 100 gal per 14,500 ft of row.	Treat trench at planting (see label).	
Fruit rots (Several pathogens)	Maneb-zinc	NTL**	See label. 2.0 lb/acre	Begin when fruit starts to turn pink; repeat at 10-14-day intervals.	Practice crop rotation.
	Zineb	NTL**	See label. 2.0 lb/acre	Same as above.	

* Does not apply.
** No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
PEPPER					
Seed decay and Damping-off	(See seed treatment lists—captan, dichlone, thiram, and zineb.)				
POTATO (IRISH)					
Early blight (Alternaria solani) and Late blight ** (Phytophthora infestans)	Anilazine	NTL*	1.0-2.5 lb/acre	For all chemicals: Begin treatment immediately at first appearance of disease, or when plants are small for protection. Continue applications at 5-10-day intervals as needed.	If disease pressure is severe or conditions warrant, shorten treatment intervals to 3-5 days. Caution: Late blight is a very rapid (explosive) disease and requires constant monitoring.
	Captafol	NTL*	0.75-1.5 lb/acre		
	Chlorothalonil	NTL*	0.75-1.125 lb/acre		
	Fentin hydroxide	7	2.4-4.9 oz/acre		
	Mancozeb	NTL*	0.8-1.6 lb/acre		
	Maneb	NTL*	1.2-1.6 lb/100 gal 1.2-3.9 lb/acre		
	Maneb-zinc	NTL*	0.8-1.6 lb/100 gal 0.8-1.6 lb/acre		
	NIA 9102	NTL*	0.8-1.6 lb/100 gal 0.8-1.6 lb/acre		
Black leg (Erwinia carotovora) and Soft rot (seed pieces)	Streptomycin sulfate	—***	100 p/m as a spray.	Soak cut seed pieces for 1-30 min and plant.	Eradicate seed corn maggots. Seed piece treatment only.
Black scurf or Stem canker (Rhizoctonia solani)	PCNB	—***	See label. 10 lb/20 gal/acre	Apply treatment to 12,400-13,000 linear ft in 12- to 14-in bands and incorporate into soil before planting seed pieces.	Other methods available; see manufacturer's label.
Seed piece decay (rot)	Captan (dust)	—***	See label. 0.75-1.44/lb cwt/acre	Treat seed pieces after cutting.	Use according to each manufacturer's directions.
	Mancozeb (dust)	—***	See label. 0.04-0.08/lb cwt	Same as above.	Do not use treated seed pieces for food or feed.
	Maneb	—***	See label. 1.0 lb/10 gal or 8% dust.	Same as above.	Same as above.
	NIA 9102 (dust)	—***	See label. 0.07-0.11/lb cwt	Same as above.	Same as above.

* No time limit.
** Resistant varieties are available.
*** Does not apply.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
POTATO (IRISH)					
Fusarium tuber rot (*Fusarium* spp.) Seed and market	Thiabendazole	—*	See label. 1,500 p/m, suspension —42 fl oz of 42.28% FS/100 gal H_2O.	Treat at rate of 1 gal/ton of unwashed tubers entering storage on a conveyor line and/or dip 20 seconds or respray before cutting seed pieces.	
Common scab (*Streptomyces scabies*)	Select resistant varieties where possible.				
PUMPKIN	(See Cantaloup, Watermelon, Pumpkin, and Squash.)				
RADISH					
Downy mildew (*Peronospora parasitica*) and Leaf spots (*Alternaria* spp.)	Zineb	NTL**	0.75-1.5 lb/100 gal 1.0-2.4 lb/acre	Begin treatment immediately at first sign of disease; repeat at 7-10-day intervals.	
RHUBARB (greenhouse)					
Leaf rot (Gray mold) and (*Botrytis cinerea*)	Captan	NTL**	1 lb/100 gal	Apply following budding and at weekly intervals until harvest.	Greenhouse use only.
ROMAINE					
Downy mildew (*Bremia lactucae*)	Zineb	10	0.75-1.5 lb/acre	Begin treatment immediately at first sign of disease; repeat at 7-10-day intervals.	
RUTABAGA					
Powdery mildew (*Erysiphe polygoni*)	Sulfur	NTL**	See label. 6-25 lb/acre	Begin application at first appearance of disease; repeat at 7-10-day intervals as required.	
SHALLOT	(See Onion and Garlic.)				

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* Does not apply.
** No time limit.

VEGETABLE DISEASES

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
SPINACH					
Blue mold (Peronospora effusa) and White rust (Albugo occidentalis)	Maneb	10	1.2-1.6 lb/100 gal 1.0-2.1 lb/acre	Begin treatment when disease first appears; repeat at 7-10-day intervals.	Remove excess residues by washing.
Seed decay and Damping-off	(See seed treatment lists—captan, dichlone, fenaminosulf, thiram, and zineb.)				
SQUASH	(See Cantaloup, Watermelon, Pumpkin, and Squash.)				
SWEET CORN (Garden-fresh market)					
Helminthosporium leaf blights * (Helminthosporium maydis and H. turcicum)	Captafol (Florida only)	5	3-5 gal/acre 0.4-1.0 lb/acre	2-4 day schedule, see label.	(Florida only) Fresh market only, do not feed forage.
	Chlorothalonil	14	1.125-1.5 lb/acre	Apply treatments at first sign of disease; repeat at 4-7-day intervals or as needed.	Do not graze treated fields. Do not use treated corn for feed or forage.
	Mancozeb	7	1.2 lb/acre	Same as above.	
	Maneb	NTL**	1.2 lb/100 gal 0.9-2.25 lb/acre	Begin when plants are 6 in high; repeat at 3-7-day intervals until harvest.	Do not feed treated forage to livestock.
	Zineb	NTL**	1.1-1.5 lb/acre	Apply treatments at first sign of disease; repeat at 4-7-day intervals as needed.	Do not feed treated forage or husks to dairy animals or animals being finished for slaughter.
Rust * (Puccinia sorghi),	Zineb	NTL**	1.1-1.5 lb/acre	Same as above.	Same as above.
Smut * (Ustilago maydis),	Select resistant varieties for your area—controlled by resistance.				
Stewart's wilt * (Bacterium stewartii)	Select resistant varieties adaptable in your area.				
Seed decay and Damping-off	(See seed treatment lists—captan, dichlone, and thiram.)				

USE PESTICIDES SAFELY – READ THE LABEL

* Some resistant varieties are available.

** No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
SWEETPOTATO Black rot (*Ceratocystis fimbriata*)	Thiabendazole	—*	8 fl oz of 42.28% FS/7.5 gal dip suspension.	Dip seed (roots) before bedding. Use certified "seed" (roots). Use new land for plant beds or treat old beds with methyl bromide. Follow a 3- or 4-year rotation when disease has been a problem. Dip roots for 1-2 minutes and plant immediately.	Do not rinse. Do not use treated "seed" (roots) for food or feed.
Foot rot (*Plenodomus destruens*)	Thiabendazole	—*	Same as for black rot.	Same as for black rot.	Do not rinse. Do not use treated "seed" (roots) for food or feed.
Southern blight or Cottony rot (*Sclerotium rolfsii*)	DCNA	—*	0.75 lb/7.5 gal H_2O —seed dip; 2.8 lb/14 gal H_2O/1,000 sq ft of bed—bed spray.	Treat seedbed soil with methyl bromide or put bed where grass crops have grown for 2 years. Dip roots 10-15 seconds in well-agitated suspension of DCNA. Drain roots and bed promptly. Prepare fresh suspension daily. As a bed spray, spray or sprinkle over bedded roots before covering with soil.	Do not plant tomatoes as a followup crop in treated soil. Do not use spent roots for food or feed.
	MBR	—*	2 lb/100 sq ft of plant (seed) bed		
Fusarium wilt (Stem rot) ** (*Fusarium oxysporum* f. sp. *batatas*) and	Select resistant varieties.				
Soil rot (Pox) ** (*Streptomyces ipomoeae*)	Select resistant or tolerant varieties.				
Scurf (*Monilochaetes infuscans*)	DCNA	—*	0.75 lb/7.5 gal H_2O (seed dip).	Dip seed potatoes 10-15 seconds in well-agitated suspension. Drain and bed promptly. Prepare fresh suspension daily.	Use certified seed potatoes. Do not use treated roots for food or feed. Bed and plant in soil free of scurf—use rotation. Use cut sprouts (free of underground parts—cut above soil level), or use vine cuttings. Always harvest and store sweetpotatoes in clean containers and storage houses.
			2.8 lb/14 gal H_2O for 1,000 sq ft of bed (bed spray).	Spray or sprinkle over bedded roots before covering.	
	Thiabendazole	—*	8 fl oz of 42.28% FS/7.5 gal H_2O (seed dip).	Same as for black rot.	
	Thiram	—*	0.75 lb/7.5 gal H_2O	Dip roots for 0.5 minute in suspension. Plant sprouts promptly after treatment.	

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* Does not apply.
** Resistant varieties are available.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
TOMATO					
Bacterial spot (*Xanthomonas vesicatoria*) (plant bed)	Streptomycin sulfate	—*	0.17 lb/100 gal 200 p/m as a spray	Treat at first appearance of disease; repeat at 5-10-day intervals until transplants are removed.	Plant beds only.
	Streptomycin sulfate + one of the following: Copper ammonium carbonate Copper-ammonium complex Copper hydroxide Copper oxychloride sulfate Copper salts of fatty and rosin acids or Fixed copper (basic copper sulfate)	—*	See label.		
Bacterial spot (*Xanthomonas vesicatoria*) (field)	Mancozeb or	5	1.2 lb/acre	Treat at first appearance of disease; repeat at 5-10-day intervals.	
	Maneb + one of the following:	5	1.2 lb/acre		
	Copper ammonium carbonate, Copper-ammonium complex Copper hydroxide Copper oxychloride sulfate, Copper salts of fatty and rosin acids. or Fixed copper (basic copper sulfate)	NTL**	See label.		
Southern blight (*Sclerotium rolfsii*)	PCNB	—*	7-7.5 lb/100 gal 7-7.5 lb/7,300 linear ft of row for nonstaked plants or/10,000 linear ft for staked tomatoes	Treat soil in trench at transplanting.	
Damping-off (plant bed)	Captan	—*	0.75 lb/100 gal 2.5 gal/100 sq ft	Drench or direct heavy spray to soil immediately following seeding.	
	Ferbam	NTL**	See label. 1.7-4 lb/acre	Treat soil before emergence of plants.	

* Does not apply.
** No time limit.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
TOMATO					
Gray mold (*Botrytis* spp.) and Early blight (*Alternaria solani*) (plant bed)	Anilazine	NTL*	0.5 lb/acre	Begin treatment when first true leaves emerge; repeat at 7-14-day intervals.	Shorter intervals should be used in some areas.
	Chlorothalonil	--**	0.75 lb/acre		
Late blight (*Phytophthora infestans*) (plant bed)	Chlorothalonil	--**	0.75 lb/acre	Treat immediately at first sign of disease; repeat at 5-10-day intervals. Shorten interval if necessary.	Some areas may require shorter intervals under severe disease pressure.
	Maneb	--**	0.8 lb/acre		
Wilts Bacterial (Southern) *** (*Pseudomonas solanacearum*),	In some areas resistant varieties are available.				
Fusarium *** (*Fusarium oxysporum* f. sp. *lycopersici*), and	Select resistant varieties.				
Verticillium *** (*Verticillium albo-atrum*)	Select resistant varieties.				
Anthracnose (*Colletotrichum phomoides*), Early blight **** (*Alternaria solani*), Gray leaf spot **** (*Stemphylium solani*), Late blight **** (*Phytophthora infestans*), Leaf mold **** (*Cladosporium fulvum*), and Septoria leaf spot (*Septoria lycopersici*)	Anilazine	NTL*	1.0 lb/acre	For all chemicals: Treat within 8 days after transplanting; repeat at 5-10-day intervals as necessary for good control.	Shorter intervals required in some locations. Exclusions: *Anilazine*--Leaf mold. *Chlorothalonil*--Septoria leaf spot. *Mancozeb*--Leaf mold, Septoria leaf spot.
	Chlorothalonil	NTL*	1.5 lb/acre		
	Mancozeb	5	1.2-2.4 lb/acre		
	Maneb	5	1.2-1.6 lb/100 gal 1.2-1.6 lb/acre		

* No time limit.
** Does not apply.
*** Some resistant varieties are available.
**** Resistant varieties are available.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
TOMATO					
Gray mold (Botrytis cinerea) (Above diseases also)	Anilazine plus Maneb or Mancozeb	5	0.5 lb/100 gal 0.8 lb/100 gal 0.8 lb/100 gal	Combination fungicides: Treat within 3 days after transplanting or at first appearance of disease; repeat at 5-10-day intervals.	In some areas intervals may be shortened.
	Anilazine	NTL*	0.75-1.5 lb/acre	Apply treatment within 3 days after setting or at very first appearance of disease; repeat at 5-10-day intervals.	Intervals may be shortened in some areas.
	Chlorothalonil	—**	1.5 lb/acre		
Gray mold (Botrytis cinerea), Leaf mold (Cladosporium fulvum), Cercospora leaf mold (Cercospora fuligena), Phoma rot (Phoma destructiva), and Sclerotinia stem rot (Sclerotinia sclerotiorum)	Benomyl	NTL*	0.25-0.5 lb/acre	Apply treatment at very first appearance of disease; repeat at 7-14-day intervals.	
Anthracnose (Colletotrichum phomoides), Early blight *** (Alternaria solani), Gray leaf spot *** (Stemphylium solani), Fruit rot and Nailhead spot (Alternaria tomato)	Captafol	NTL*	1.25-2.5 lb/acre	Begin treatment at first appearance of disease; repeat at 5-10-day intervals as necessary.	For machine-harvested tomatoes only.

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* No time limit.
** Does not apply.
*** Resistant varieties are available.

Crop and Disease	Fungicide	Min. days from last application to harvest or feeding	Dosage (Active Ingredient)	Where and when to apply	Safety restrictions and remarks
TURNIP	(See Mustard and Turnip Greens.)				
WATERMELON	(See Cantaloup, Watermelon, Pumpkin, and Squash.)				

Only nematicides registered for specific use under the requirements of the Federal Insecticide, Fungicide, and Rodenticide Act are listed in this handbook. The data are arranged in three major parts: General information on current nematicides, including alternatives to nematicides for management of nematodes; nematicide index, toxicity tables, and summaries; and tables of suggested nematicide uses. All three parts should be consulted before acting on any of these suggestions.

GENERAL INFORMATION ON CURRENT NEMATICIDES

Information discussed here concerns the amount of nematode control required, how nematicides work in soil, the toxicity of registered nematicides to warm-blooded animals, and precautions related to nematicide use.

Amount of Nematode Control Required

The amount of nematode control required for a given crop is determined by the length of time that control is considered important, the value of the crop, the importance of the control for economical production of the crop, or the need to meet the requirements of certification and quarantine. The most important consideration is economic; optimum nematicide applications are those that result in the most profitable crop value increases in proportion to the expense involved.

For most field and truck crops, a reduction of approximately 85 percent of the nematode population before or at planting will eliminate nematodes as a limiting factor in crop growth for one growing season. In seedbeds, nurseries, orchards, and vineyards, greater control is necessary to provide a longer period of protection. Complete elimination, or eradication, of nematodes from field soils is seldom either possible or practical. To satisfy quarantine requirements for dangerous nematode species, it may be necessary to consider treating small amounts of soil by chamber (or space) fumigation or treating plant materials by chamber fumigation, bare-root dips, or soaks, after they have been freed of soil.

Several nematicides are able to diffuse through the soil and frequently are called "soil fumigants." Other nematicides are contact in nature and have little or no volatility and do not diffuse through the soil to any appreciable extent. Certain nematicides are "soil sterilants" and control insects, fungi, and weeds as well as nematodes.

Nematicidal dosages for row application are based on the amount of nematicide used per linear foot of row. For this reason wide row spacings require less chemical per acre than close row spacings. Dosages for overall applications are those required to treat 1 acre-foot of soil and are not related to the row spacing of crops grown on the land. The suggestions for band and strip applications are calculated on the basis of the proportionate part of an acre that is treated at an overall dosage.

How Nematicides Work in Soil

Fumigant nematicides, such as 1,3-D and methyl bromide (MBR), form vapors in the soil, which move several inches from the point of application. Distance of movement is influenced by soil porosity, particle size, soil temperature, soil moisture, and percent colloidal and organic matter.

Several of the newer nematicides, especially the organophosphate and carbamate insecticide-nematicides, have low volatility and are considered contact nematicides because the active ingredients do not diffuse through the soil to any significant extent. Dispersion of these chemicals in the soil to ensure contact of the nematicides with nematodes in soil spaces depends on mechanical mixing or movement by irrigation water and natural rainfall.

The degree of kill is determined by the concentration and location of the nematicide in the soil and the length of time the nematodes are exposed to the nematicide. These factors are seldom under the control of the user and, in practice, kill usually can be increased only by increasing the application rate. However, increasing the application rate beyond a certain point does not necessarily result in economically significant increases in nematode kill or crop yield. This relationship is the basis for current dosage suggestions.

The nematicide dosages in this guide are those that have been found by experiment to produce the best crop yield increases with the least amount of nematicide. In most cases the suggested dosage may kill about 85 to 90 percent of the nematodes if conditions of use and application are proper.

If soil moisture is extremely high when nematicides are applied, pore spaces will be filled with water, which restricts diffusion of nematicides. Nematode control is best when the soil moisture is about 80 percent of the field capacity. Under these conditions nematicides move readily in the soil. On the other hand, if soil moisture is low, results will be poor because the chemicals may escape from the soil or decompose before kill is appreciable. The soil temperature should be between 60° and 75°F for best results.

Clay soils and soils high in organic matter require from 20 to 40 percent more nematicides for effective control than sandy soils. This is because clay soils have more total pore space to be filled with fumigant vapor than sandy soils and because colloidal and organic matter often will absorb large quantities of some nematicides.

Toxicity of Nematicides

All the nematicides listed in this handbook may be toxic to man and animals, if they are used without proper precautions or under conditions contrary to those stated on product labels. Reading and following the directions on nematicide labels will reduce the potential danger to man and animals and also will reduce such potential dangers as persistence of residues in the soil and on plants.

Available toxicity data for registered nematicides are shown on pages 204 and 205. The first list contains data on acute oral and dermal (AO and AD) levels, expressed as LD (lethal dosage)$_{50}$ values, and acute and chronic vapor toxicity (VA and VC) levels for registered fumigant nematicides. The second list contains data on acute oral and dermal LD_{50} values for registered organophosphate and carbamate nematicides.

Data in these lists are from manufacturers' technical data sheets and from the "Kenaga Index" (E.E. Kenaga and W.E. Allison. Commercial and Experimental Organic Insecticides, 1971 Revision, Separate Publication, Entomol. Soc. Am.).

Precautions Related to Nematicide Use

Choice of Nematicides

The nematicides listed can be considered as available to control plant-parasitic nematodes as preplant soil treatments, as treatments applied at the time of planting, and as postplant treatments applied on and around established plants. In addition, other related facts are included, such as suggested dosage ranges and time and place of application of treatments.

The mention of nematode parasites by genus or species or common name indicates that the treatment is specific for those nematodes listed. Where nematode names are not mentioned, the treatment is effective for nematodes in general.

The uses suggested here are general in nature and do not necessarily apply to all areas or parts of the country. Several may not be economically feasible. In specific production situations, nematicide information shown here should be checked with local county agents, State experiment station extension specialists, and manufacturers' technical representatives. They will be able to determine the suitability of specific nematicides for specific nematode problems after consideringf local soil temperature and moisture conditions, cultural practices, and dosage rates.

Safety of Personnel

The directions and warnings on product labels or in other available literature should be followed to avoid contamination of skin, clothing, and equipment and to avoid swallowing or breathing vapors of any of the nematicidal chemicals in this guide. Proper safety equipment as suggested on product labels and in other literature should be worn by operating personnel. This should include goggles, respirators that protect against organic vapors, gloves, coveralls, aprons, and shoe covers. Proper methods of disposing of empty chemical containers, as suggested on product labels and in other literature, should be followed. Products should be stored in original containers in locked cabinets.

This handbook does not list all registered pesticide uses but rather includes only those pesticides which have been fully evaluated by ARS and CES scientists and considered to be efficacious and practical.

ALWAYS CONSULT PRODUCT LABEL BEFORE USE

ALTERNATIVES TO NEMATICIDES FOR MANAGEMENT OF NEMATODES

Although the use of nematicides is an effective method of managing nematode populations, other methods may be used in place of or in conjunction with nematicides. These methods include crop rotation, use of resistant cultivars, and such cultural practices as fallow, timing of planting, and timely irrigation and(or) fertilization. The end results of control approaches involving the use of nematiticides, crop rotations, resistant cultivars, and cultural practices may vary greatly. Because crops are grown over a wide geographical area where cultural practices, cultivars, alternate crops, environmental conditions, and nematode species differ, the user should rely upon recommendations furnished by local agricultural specialists that offer the most efficient, economical, and environmentally safe control practice or combinations of practices for a given nematode problem.

Crop Rotation

Crop rotation has proved effective for managin nematodes on several annual crops. Most of the cys nematodes have few hosts, and it is usually easy to design rotations of different crops to prevent or minimize yield reductions. This is especially helpful since it is necessary to use high rates of nematicides to control cyst nematodes. Peanuts are not attacked by the root-knot nematode, *Meloidogyne incognita*, and can be used to reduce populations of this nematode. In Georgia, 2-year intensive cropping systems including sweet corn-soybean-wheat-soybean-spinach and turnip-peanut-cucumber-turnip-cucumber-soybean were effective in suppressing populations of *M. incognita*. Generally, good weed control is required for successful suppression of nematodes with crop rotation.

Resistant Cultivars

Certain crop cultivars are resistant to various nematode species and do not require use of nematicides for successful culture. Alfalfa, cotton, soybean, tobacco, vegetables, and several other crops are resistant to the root-knot nematode, *Meloidogyne incognita*. There are soybean and potato cultivars resistant to cyst nematodes. Rotation of resistant cultivars with other crops often aids in the long-term use of resistant cultivars.

Cultural Practices

Clean fallow of land may effectively reduce nematode populations to below damaging levels. Good weed control is necessary, to eliminate weed hosts of the nematode being suppressed. Generally, this would only be considered in the production of high-value crops, such as nursery and ornamental plantings.

Damage caused by certain nematodes can be reduced by timely irrigation and under certain conditions by fertilization. This can be helpful for turf, flower, ornamental, and some fruit crops and would be especially helpful around residences, where many nematicide uses are prohibited.

Early planting of sugar beets at soil temperatures below 10°C lessens the damage caused by the sugar beet cyst nematode, *Heterodera schachtii*. As the soil temperature increases, the number of nematodes required to damage plants decreases. In long-season warm climate regions, certain vegetable crops may be planted in winter months and harvested before injury occurs. Potatoes can be planted in the San Joaquin Valley of California early in the year, and in Georgia turnips for greens are planted in February. These crops are harvested before damage occurs because the root-knot nematodes are less active and cause less damage in cooler weather.

Alternative management approaches are used occasionally in conjunction with nematicides to decrease the amount of nematicide used and(or) amount of damage caused by the nematodes. In Florida, growing soybeans resistant to root-knot nematode and soil treatment with a nematicide in rotation with corn was the optimum treatment for long-term management of this nematode on soybeans. In areas where the peanut root-knot nematode, *M. arenaria*, occurs in the same field with the soybean cyst nematode, an effective management practice is growing a soybean cultivar resistant to soybean cyst nematode and applying a nematicide to control the root-knot nematode.

NEMATICIDE INDEX AND TOXICITY TABLES

The Nematicide Index is a list of registered chemicals referred to in the nematode section of this handbook. The nematicides underlined in the left-hand column are the names that are used in the tables of suggested nematicide uses. An ® after a name indicates a registered trade name. Approved common names are used when available and are in lower case. The chemical name is given for each nematicide, and the index is cross-referenced to indicate additional trade names or other designations.

Acute oral and dermal LD_{50} values and(or) vapor toxicity values for the nematicides named in the index are given in the two tables on pages 204 and 205.

NEMATICIDE INDEX

Material[1]	Chemical Name[2] (and additional designations)
AC 3911	see phorate
AC 64475	see fosthietan
Acconem	see fosthietan
aldicarb	2-methyl-2-(methylthio)propionaldehyde O-(methylcarbamoyl)oxime (Temik®, UC 21149)
Alfa-tox®	see diazinon
Basudin®	see diazinon
BAY 25141	see fensulfothion
Bed Fume®	see MBR
Brom-O-Gas®	see MBR
bromomethane	see MBR
Brozone®	see chloropicrin and MBR
carbofuran	2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate (Furadan®, NIA 10242)
Chem-Vape®	see metham
chloropicrin	trichloronitromethane (Brozone® (in part), Dowfume®MC-2 (in part), Dowfume® MC-33, Larvacide®, Nemex® (in part), Picfume® in mixture with Telone®, Terr-O-Cide® (in part), Terr-O-Gas® (in part), Vorlex®-201 (in part))
CL 64475	see fosthietan
Counter®	see terbufos
1,3-D	1,3-dichloropropene and related chlorinated C_3 hydrocarbons (DD, D-D® mixture, Nemex® (in part), Telone®, Vidden®D, and in mixture with chloropicrin or methyl isothiocyanate, or both (DD-MENCS, DD/PIC®, Telone® C-17 Terr-O-Cide®15-D, Terr-O-Cide®30-D, Vidden®DC-15, Vorlex®, and Vorlex®-201)
Dasanit®	see fensulfothion

Material[1]	Chemical Name[2] (and additional designations)
DD	see 1,3-D
DD-MENCS	see 1,3-D
DD/PIC®	see 1,3-D
D-D® mixture	see 1,3-D
demeton	mixture of *O*,*O*-diethyl *S*(and *O*)-[2-(ethylthio)ethyl] phosphorothioates (mercaptophos, Meta-Systox®-R, Systox®)
diazinon	*O*,*O*-diethyl *O*-[6-methyl-2-(1-methylethyl)-4-pyrimidinyl] phosphorothioate (Alfa-Tox®, Basudin®, Diazitol®, Dipofene®, FW 152, G 24480, Sarolex®, Gardentox®, Spectracide®)
Diazitol®	see diazinon
1,3-dichloropropene	see 1,3-D
dichloropropene-dichloropropane	see 1,3-D
Dipofene®	see diazinon
Dowfume®MC-2	see chloropicrin and MBR
Dowfume®MC-33	see chloropicrin
ethoprop	*O*-ethyl *S*,*S*-dipropylphosphorodithioate (Mocap®, V-C 9-104)
FW 152	see diazinon
fensulfothion	*O*,*O*-diethyl *O*-[*p*-(methylsulfinyl)phenyl] phosphorothioate (Dasanit®, Terracur P®, S 767, BAY 25141)
fosthietan	diethyl 1,3-dithietan-2-ylidenephosphoramidate (AC 64475, Acconem, CL 64475, Geofos, Nem-A-Tak®)
Furadan®	see carbofuran
G 24480	see diazinon
Gardentox®	see diazinon
Geofos	see fosthietan
Larvacide®	see chloropicrin
MBR	bromomethane or methyl bromide (Bed Fume®, Brom-O-Gas®, Brozone® (in part), Dowfume®MC-2 (in part), Meth-O-Gas®, Panobrome®, Pestmaster®, Terr-O-Gas® (in part), Weedfume®)

Material[1]	Chemical Name[2] (and additional designations)
MBR-CP	see MBR methyl bromide (98%) plus chloropicrin (2%)
mercaptophos	see demeton
metam	see metham
metam sodium	see metham
Meta-Systox®-R	see demeton
metham	sodium methyldithiocarbamate (Chem-Vape®, metam, metam sodium, metham sodium, Mycoban®, Trimaton®, Vapam®, VPM)
metham sodium	see metham
Meth-O-Gas®	see MBR
methyl bromide	see MBR
Mocap®	see ethoprop
Mycoban®	see metham
Nemacur®	see phenamiphos
Nem-A-Tak®	see fosthietan
Nemex®	see chloropicrin and 1,3-D

Material[1]	Chemical Name[2] (and additional designations)
NIA 10242	see carbofuran
oxamyl	methyl *N*',*N*'-dimethyl-*N*-[(methylcarbamoyl)oxy]-1-thiooxamimidate (Vydate®)
Panobrome®	see MBR
Pestmaster®	see MBR
phenamiphos	ethyl 4-(methylthio)-*m*-tolyl isopropylphosphoramidate (Nemacur®)
phorate	*O*,*O*-diethyl *S*-[(ethylthio)methyl] phosphorodithioate (AC 3911, Thimet®)
Picfume®	see chloropicrin
S 767	see fensulfothion
Sarolex®	see diazinon
SMDC	see metham
Spectracide®	see diazinon
Systox®	see demeton
Telone®	see 1,3-D
Temik®	see aldicarb

Material[1]	Chemical Name[2] (and additional designations)
Terracur P®	see fensulfothion
Terr-O-Cide®	see 1,3-D and chloropicrin
Terr-O-Gas®	see MBR and chloropicrin
terbufos	S-[[(1,1-dimethylethyl)thio]methyl] O,O-diethyl phosphorodithioate (Counter®)
Thimet®	see phorate
trichloronitromethane	see chloropicrin
Trimaton®	see metham

Material[1]	Chemical Name[2] (and additional designations)
UC 21149	see aldicarb
Vapam®	see metham
V-C 9-104	see ethoprop
Vidden®D	see 1,3-D
Vorlex®	see 1,3-D
Vorlex®-201	see 1,3-D and chloropicrin
VPM	see metham
Vydate®	see oxamyl
Weedfume®	see MBR

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[1] An ® after the name indicates a registered trade name. Common names are used when available and are usually in lower case. In the left-hand column, the name underscored is the name used in this publication.

[2] A chemical name occupying 2 lines separated by an equal (=) sign is joined together without any separation if written on 1 line.

TOXICITY TABLES

Acute oral and dermal levels and acute and chronic vapor toxicity levels for registered fumigant nematicides

[All measures are Mg/kg]

Nematicide	AO LD_{50}[1]	AD LD_{50}[1]	VA[2]	VC[2]
chloropicrin	---	---	[3]20	0.1
DD	140	2,100	---	---
DD-MENCS (MENCS fraction only)	100	[4]CO, (m) 30	---	---
1,3-D	---	---	500	1.0
MBR	---	---	200	20
metham	820, (m)285	(rb) 800	---	---

[1] Acute oral (AO) and acute dermal (AD) levels expressed as LD_{50} values for white rats except for rabbit (rb) and white mouse (m).

[2] Acute vapor (VA) and chronic vapor (VC) toxicity levels for man in p/m.

[3] Lethal dose is 0.8 mg/liter or exposure for 30 minutes.

[4] CO = chronic oral toxicity (90 days or more) no effect level (p/m in diet).

Acute oral and dermal levels for registered organophosphate and carbamate nematicides

[All measures are Mg/kg]

Nematicide	AO LD_{50}[1]	AD LD_{50}[1]
aldicarb	1	(rb) 5
carbofuran	5	(rb) 885
demeton	2-12	8-200
diazinon	66-600	379-1,107
ethoprop	61	(rb) 26
fensulfothion	2-11	3-30
fosthietan	[2]5-8	(rb) 27-66
oxamyl	[3]5	---
phenamiphos	8-10	(rb) 178-225
phorate	1-5	2-7
terbufos	[4]4-9	(rb) 1

[1] Acute oral (AO) and acute dermal (AD) levels expressed as LD_{50} values for white rats except for rabbit (rb).

[2] Acute oral (AO) for 15G formulation and 2L formulation are 42 - 44 and 26 - 33, respectively; acute dermal (AD) for 15G formulation and 2L formulation are 252 - 331 (rb) and 37 (rb), respectively.

[3] Acute oral (AO) and acute dermal (AD) for 24% L formulation are 37 and 2960 (rb), respectively.

[4] Acute dermal (AD) for 15G formulation - wet is 29 - 34 (rb) and for 15G formulation - dry 900 - 1425 (rat).

NEMATICIDE SUMMARIES

Three nematicide summaries follow. The first is a list of descriptions of materials. The second is a list of nematicides arranged by time of application. The third is a list of nematicides arranged by crop types and uses and includes general dose ranges. These summaries are arranged for easy reference and are intended to direct the reader to the third section, the tables of suggested nematicide uses, pages 216 to 274.

Several of these registered chemicals are intended to be used alone, and others are component parts of nematicidal mixtures. Information on the amount of nematode control required, how nematicides work in soil, toxicity of nematicides, and precautions related to nematicide uses is discussed on pages 195 to 197.

Descriptions of Materials

Preplant Nematicides

These chemicals are fumigants and are highly toxic to both plants and fungi. They are discussed here because of their specific ability to kill nematodes in soil before planting. Soil applications with these chemicals are made several weeks to several months before planting to allow proper intervals for nematode kill and for aeration of the soil to avoid phytotoxicity.

chloropicrin (trichloronitromethane; nitrochloroform).--This fumigant is available as a 96.5 to 100 percent active liquid and weighs approximately 13.75 pounds per gallon. It may be used alone as a nematicide or combined with methyl bromide (98 percent methyl bromide plus 2 percent chloropicrin) in several products in which the chloropicrin acts as a warning agent. It may also be combined with other chemicals, such as 1,3-D. Chloropicrin is a lachrymator and is not suitable for home garden use.

1,3-D (1,3-dichloropropene and related C_3 hydrocarbons).--This fumigant is an undefined and variable mixture of chlorinated C_3 hydrocarbons. The main component and most active constituent is 1,3-dichloropropene. Three basic formulations of the chemical are registered:

(I) 92% 1,3-dichloropropene; other C_3 hydrocarbons are not labeled as active ingredients; sold as Telone®II.
(II) 100% 1,3-dichloropropene and related chlorinated aliphatics; related C_3 hydrocarbons are labeled as active ingredients; contains 78 percent 1,3-dichloropropene; sold as Telone®.
(III) 99 or 100% chlorinated aliphatics or 100 percent chlorinated C_3 hydrocarbons; all C_3 hydrocarbons are labeled as active ingredients; contains 50 to 55 percent 1,3-dichloropropene; sold as D-D® and Vidden®D. The above formulations may be combined with other fumigants to create the following formulations.
(IV) 74% of (I) plus 16.5% chloropicrin; sold as Telone®C-17.
(V) 85% of (III) plus 15% chloropicrin; sold as Vidden®DC-15, Terr-O-Cide®15-D, or DD/PIC®.
(VI) 70% of (III) plus 30% chloropicrin; sold as Terr-O-Cide®30-D.
(VII) 80% of (III) plus 20% methyl isothiocyanate; sold as Vorlex®.
(VIII) 68% of (III) plus 17% methyl isothiocyanate plus 15% chloropicrin; sold as Vorlex®-201. Because of the different formulations, rates vary greatly. One gallon contains approximately 10 pounds of technical compound. Soil applications may be made in spring or fall or whenever soil temperature, moisture conditions, and weather are suitable.

MBR (methyl bromide; bromomethane).--This chemical, which boils at 41°F, is a gas at normal temperatures and usually is confined in containers under pressure. It may be used alone or in formulations with chloropicrin. It is applied as a liquid by soil injection; as a gas released at the surface under gas-proof covers to previously conditioned soil or other materials; or as a gas applied as a space fumigant to soil, plant parts, and nematode-contaminated material.

metham (sodium methyldithiocarbamate).--This fumigant is available as 31 percent and 32.7 percent (anhydrous basis) aqueous solutions. The latter solution contains 3.1 pounds active anhydrous chemical (equal to 4 pounds of the dihydrate) per gallon. It is most effective when sprinkler or flood irrigation is used to distribute metham vertically in the soil. Applications may be made by soil injection, drench, or spray in front of a rotary tiller. Distribution of metham through the soil is enhanced by adding from 1 to several acre-inches of water after the chemical has been applied.

Preplant and Postplant Nematicides

The chemicals listed here may be used to treat soils before planting and, under specific circumstances, may be used as a postplant treatment on and around living plants.

ethoprop (*O*-ethyl *S*,*S*-dipropylphosphorodithioate).--This chemical is available as a 5, 10, or 15 percent granular mixture for use on a variety of crops. It may also be used by commercial or professional personnel on established commercial and residential turf. Do not use on newly seeded areas until grass is well established. Do not cut or handle sod or turf for 21 days after treatment.

fensulfothion (*O*,*O*-diethyl *O*-[*p*-(methylsulfinyl)phenyl] phosphorothioate).--This nonvolatile contact nematicide must be mixed into soil or distributed downward in soil with water to attain best effects. It is available as a 63.5 percent spray concentrate (6 pounds per gallon) or as 10 and 15 percent granular mixtures. It may be used on a variety of crops.

oxamyl (methyl *N'*,*N'*-dimethyl-*N*-[(methylcarbamoyl)oxy]-1-thiooxamimidate).--This chemical is available as a 24 percent water-soluble liquid (2.0 pounds active/gallon) and as a 10 percent granular product. It is systemic in certain plants when applied to the soil or to the foliage. It is registered for use on a large number of plants for preplant, at planting, or postplant treatments.

Postplant Nematicides

This list also includes those chemicals that can be used at the time of planting. Of the eight chemicals listed here, three are restricted to uses on nonfood crops.

aldicarb (2-methyl-2-(methylthio)propionaldehyde *O*-(methylcarbamoyl)oxime).--This chemical is available as a 10 or 15 percent granular mixture. Aldicarb is registered for use on a variety of crops at the time of planting and as a postplant treatment on citrus.

carbofuran (2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate).--This chemical is available as a 5 or 10 percent granular mixture and as an emulsifiable concentrate. Carbofuran is registered for use on a number of crops at time of planting. It is labeled for postplant treatment of banana, grape (California only), and sugarcane.

demeton (*O*,*O*-diethyl *S*(and *O*)-[2-(ethylthio)ethyl] phosphorothioates).--This chemical is available as an emulsifiable concentrate containing 26.2 percent demeton (2 pounds per gallon) and 2.3 percent related organophosphates. A systemic chemical that penetrates the plant tissue and is translocated, demeton is registered for use on daffodil, chrysanthemum, lily (Croft lily may show toxicity), and primrose to control foliar nematodes.

diazinon (*O,O*-diethyl *O*-[6-methyl-2-(1-methylethyl)-4-pyrimidinyl] phosphorothioate).--This chemical is available as an emulsifiable concentrate containing 46.2 percent diazinon (4 pounds per gallon) formulated in xylene. It is registered for use on turf and lawns. Do not graze livestock in treated areas. Keep children and pets off treated grass until spray has dried.

fosthietan (diethyl 1,3-dithietan-2-ylidenephosphoramidate).--This chemical is available as a 21.7 percent (2 pounds active/gallon) or 43.8 percent liquid concentrate. This soil nematicide is registered for use on tobacco only.

phenamiphos (ethyl 4-(methylthio)-*m*-tolyl isopropylphosphoramidate).--This chemical is available as 10 and 15 percent granular product and as 35 percent emulsifiable concentrate containing 3.0 pounds active/gallon. It is used on some brussels sprouts, cabbage, cotton, fruit trees, ornamentals, peanuts, soybeans, and turf. Do not graze treated areas.

phorate (*O,O*-diethyl *S*-[(ethylthio)methyl] phosphorodithioate).--This chemical is available as a 5 or 10 percent granular mixture. It is a systemic chemical and is absorbed by and translocated in the plant. It is registered only for use on Easter lilies grown for bulb production in the Pacific Northwest and may be used by professional nurserymen and florists only. It is not for home use.

terbufos (*S*-[[(1,1-dimethylethyl)thio]methyl] *O,O*-diethyl phosphorodithioate).--This chemical is available as a 15 percent granular product and is registered for use on corn (field, pop, and sweet).

Nematicides Arranged by Time of Application

Preplant Soil Treatments

aldicarb--for dry beans and Swiss chard
chloropicrin
1,3-D--1,3-dichloropropene
ethoprop--preplant treatment for sweet potatoes but can be used for selected crops
fensulfothion--selected crops
fosthietan--tobacco only
metham--sodium methyldithiocarbamate
MBR-methyl bromide--selected crops
oxamyl--selected crops

Treatments at Planting Time

aldicarb--selected crops
carbofuran--selected crops
ethoprop--selected crops
fensulfothion--selected crops
fosthietan--tobacco only
oxamyl--selected crops
phenamiphos--selected crops
phorate--commercial lily bulb production, Pacific Northwest only
terbufos--for corn (field, pop, and sweet)

Postplant Treatments

aldicarb--citrus
carbofuran--banana, grape (California only), and sugarcane
demeton--ornamentals only
diazinon--lawn grasses only
ethoprop--banana, citrus, ornamentals, peanuts, pineapple, and turf grasses
fensulfothion--bananas, citrus, ornamentals, and turf
oxamyl--selected crops
phenamiphos--apples, cherries, grape, and peach (except for California); ornamentals; and turf

ALWAYS CONSULT PRODUCT LABEL BEFORE USE

Nematicides Arranged by Crop Types and Uses

Field Crops

aldicarb--Treatment at planting time in row.
General range--1 to 5 pounds active/acre.

carbofuran--Treatment at planting time in row or for sugarcane can also be used postplant 1 or 2 weeks after harvest.
General range--1 to 6 pounds active/acre.

1,3-D--Preplant soil treatment.
General range--60 to 120 pounds active/acre in row and 120 to 250 pounds active/acre overall.

ethoprop--Treatment at planting time in row or overall.
General range--1.5 to 6.0 pounds active/acre.

fensulfothion--Treatment at planting time or for tobacco can use preplant overall.
General range--2 to 6 pounds active/acre in row or 6 to 10 pounds active/acre overall.

fosthietan--Preplant soil treatment for tobacco.
General range--1.5 pounds active/acre.

metham--Preplant soil treatment for tobacco seedbeds.
General range--3.1 to 4.8 pounds active/100 square yards if covered with gas-proof

cover, or 6.2 to 7.9 pounds active/100 square yards if sealed by rolling and sprinkling.

MBR--Preplant soil treatment for tobacco seedbeds.
General range--1 to 2 pounds active/100 square feet (up to 872 pounds active/acre). Expose to fumigation for at least 48 hours. Aerate for at least 2 days before seeding.

oxamyl--Preplant soil, transplant water, and postplant foliar treatment.
General range--4 to 6 pounds active/acre for preplant soil treatment, 0.3 to 0.5 pound active/5,600 to 9,000 plants for transplant water treatment, and 1.0 pound active/12,000 linear feet of row applied twice for the postplant foliar treatment.

phenamiphos--Treatment at planting time.
General range--1 to 2 pounds active/acre for cotton.

terbufos--Treatment at planting time for corn.
General range--0.5 pound active/1,000 linear feet of row if applied in seed furrow and 0.5 to 1 pound active/1,000 linear feet of row when applied in 7-inch band.

Flower and Ornamental Crops

aldicarb--Treatment at planting time.
General range--5 to 7 pounds active/acre for lily bulbs only.

chloropicrin--Preplant soil treatment.
General range--468 to 1,038 pounds active for field; 0.5 to 1.0 pound active/cubic yard for bulk soils.

1,3-D--Preplant soil treatment.
General range--84 to 335 pounds active/acre for overall soil treatment and planting sites of shallow-rooted ornamentals; up to 950 pounds active/acre for planting sites of deep-rooted ornamentals.

demeton--Foliar spray or postplant soil drench treatment.
General range--0.25 to 0.50 pound active in 50 gallons of water. Spray plants until thoroughly wet or apply 1 pint of this solution per square foot of bench or bed; use 0.25 pint of this solution per 6-inch pot for potted plants. Not for home garden use. For chrysanthemum, daffodils, lilies, and primroses.

ethoprop--Bare root and tuber dip or postplant soil drench treatment.
General range--0.37 pound active/100 gallons of water to 0.75 pound active/50 gallons of water. Dip bare roots and tubers in solution of 0.37 pound/50 gallons of water; drench potted plants with this solution. Drench beds and benches with solution of 0.37 to 0.75 pound active/1,000 square feet; drench field nursery stock with solution of 0.37 pound/100 gallons of water. Reduced rates for leatherleaf fern.

fensulfothion--Preplant soil treatment.
General range--1 pound active/1,000 square feet for treating beds and benches.

metham--Preplant soil treatment.
General range--124 to 505 pounds active/acre overall.

MBR--Preplant soil treatment.
General range--1 to 2 pounds active/100 square feet; 0.5 to 1 pound active/cubic yard for potting soil.

oxamyl--Preplant soil treatment, foliar spray, root, corm, or bulb dip, and postplant soil drench treatment.
General range--6 to 8 pounds active/acre. Apply liquid in minimum of 20 gallons of water for preplant soil treatment; mix liquid in 100 gallons of water and apply as dilute spray at no more than 200 gallons of spray/acre for foliar treatment; drench with solution specified on label at 4 to 8 fluid ounces/6-inch pot or 2 to 4 fluid ounces/4-inch pot; place plant material in label-specified solution for 1 to 30 minutes.

phenamiphos--At time of planting and postplant soil treatment.
General range--3.4 to 7 pounds active/acre for anthurium; 6 to 12 pounds/acre for iris, lily, and narcissus bulbs; 10 pounds/acre for leatherleaf fern; 18 pounds/acre for other selected ornamentals.

phorate--Treatment at planting time.
General range--16 pounds active/acre. For use only by professional nurserymen and florists in the production of commercially grown lily bulbs in Pacific Northwest only.

Fruit and Nut Crops

aldicarb--Treatment at planting time or postplant soil treatment.
General range--5 to 10 pounds active/acre. Incorporate granules immediately. For citrus.

carbofuran--Treatment at planting time or postplant soil treatment.
General range--0.04 to 0.09 ounce active/plant/application for banana; 10 pounds active/acre for grape applied postplant in California. Incorporate immediately.

chloropicrin--Preplant soil treatment.
General range--480 to 635 pounds active/acre overall for fields, tree sites, and nurseries; 0.5 to 1.0 pound active/cubic yard for bulk soil.

1,3-D--Preplant soil treatment.
General range--70 to 2,000 pounds active/acre.

ethoprop--Preplant soil treatment, at planting time, and postplant treatment.
General range--6 grams active/radius of 0.75 meter overall around producing banana stems; 900 p/m active solution for bare-root dip for citrus; 20 to 40 pounds active/acre overall as preplant treatment or at planting time for pineapple.

fensulfothion--Bare-root dip treatment at planting time and postplant treatment.
General range--0.15 to 0.22 ounce active/plant for banana; 575 to 860 p/m active for 30-minute root dip for citrus seedlings, or apply 0.33 pint of 113 to 226 p/m active in solution per 8-inch pot. Commercial use only.

MBR--Preplant soil treatment.
General range--up to 2 pounds active/100 square feet; up to 872 pounds active/acre for ; fruit tree planting sites; and up to 412 pounds active/acre in fruit tree nurseries 872 pounds active/acre in combination with 2 percent chloropicrin for pineapple and strawberry seedbeds and plant beds only.

Expose for 48 hours under gas-proof seal and aerate a minimum of 3 days before seeding or 5 to 14 days before setting vegetative growth.

metham--Preplant soil treatment.
General range--124 to 318 pounds active/acre or 0.338 to 0.775 pound/100 square feet overall.

oxamyl--Preplant soil treatment, at planting bare-root dip, and postplant treatment.
General range--6 to 8 pounds active/acre for preplant soil treatment; 0.5 to 1 pound active/100 gallons of water for root dip or application to foliage. Do not apply to plants under stress. Do not apply more than 2 pounds active/acre/year to plants.

phenamiphos--Preplant soil treatment or postplant treatment.
General range--10 to 20 pounds active/acre; incorporate immediately. For apples, cherries, grape, and peach except for California.

Grass and Turf

chloropicrin--Preplant soil treatment.
General range--480 to 635 pounds active/acre for field treatment; 0.5 to 1.5 pounds active/cubic yard for bulk soils.

1,3-D--Preplant soil treatment.
General range--160 to 486 pounds active/acre.

diazinon--Postplant soil treatment.
General range--40 to 54 pounds active/acre. Apply evenly over surface and follow immediately with 0.5 to 1.0 acre-inch of water.

ethoprop--Postplant soil treatment.
General range--10 to 30 pounds active/acre. Follow with 1.0 acre-inch of water. For established lawn. For home lawn use only by licensed applicators.

fensulfothion--Preplant soil treatment and postplant treatment.
General range--11 to 22 pounds active/acre overall. Drench with 0.25 to 0.5 acre-inch of water after applying evenly. For commercial use only.

metham--Preplant soil treatment for lawn seedbeds.
General range--223 to 347 pounds active/acre overall.

MBR--Preplant soil treatment for turf and lawn beds.
General range--1 to 2 pounds active/100 square feet overall. Expose 24 to 48 hours under gas-proof cover and aerate at least 2 days before seeding or 6 to 10 days before setting plants.

phenamiphos--Postplant soil treatment.
General range--0.225 to 0.45 pound active/1,000 square feet for bermuda, centipede, bentgrass, and bluegrass on golf courses, cemeteries, sod farms, industrial grounds, parkways, and roadways only. Not for home lawns or public recreation areas other than golf courses.

Oilseed and Industrial Crops

aldicarb--Treatment at planting time.
General range--1.5 to 3 pounds active/acre.

carbofuran--Treatment at planting time.
General range--2 to 5 pounds active/acre.

chloropicrin--Preplant soil treatment.
General range--480 to 1,076 pounds active/acre for field.

1,3-D--Preplant soil treatment.
General range--30 to 200 pounds active/acre in rows and 150 to 600 pounds active/acre in overall treatment.

ethoprop--Treatment at planting or postplant at pegging for peanuts. Can apply up to 1 week before planting.
General range--1.5 to 4 pounds active/acre. Apply in 12- to 18-inch bands only.

fensulfothion--Treatment at planting.
General range--1 to 4 pounds active/acre in row or 3 to 6 pounds active/acre overall.

metham--Preplant soil treatment.
General range--124 to 318 pounds active/acre.

oxamyl--Treatment at planting time and as postplant foliar treatment following preplant or at planting application of contact nematicides.
General range--3 to 6 pounds active/acre overall or 1 to 3.6 pounds active/acre in band treatment.

Vegetable Crops

aldicarb--Preplant soil treatment or at planting treatment.
General range--0.92 to 1.71 pounds active/acre for dry beans; 3 pounds active/acre for potatoes and Swiss chard.

carbofuran--Treatment at planting time.
General range--2 pounds active/acre applied in band; incorporate.

chloropicrin--Preplant soil treatment.
General range--480 to 630 pounds active/acre for seedbed soil; 0.5 to 1.5 pounds/cubic yard for bulk treatment of rooting soil; 1,021 pounds active/acre for celery seedbeds in Florida only.

1,3-D--Preplant soil treatment.
General range--42 to 200 pounds active/acre in row and 84 to 600 pounds active/acre overall (low dosage for mineral soils, high for muck and peat soils).

ethoprop--Preplant soil treatment.
General range--1.5 to 3 pounds active/acre when applied in 12- to 15-inch band on the row; 6 to 8 pounds active/acre when applied overall; for lima bean, snap bean, cucumber, sweet corn, and sweet potato.

fensulfothion--Preplant soil treatment or at planting time.
General range--1.83 pounds active/acre in 12-inch band on the row for corn; 3 to 6.9 pounds active/acre overall for sweet potato; 10 to 20 pounds active/acre overall or 3.2 to 6.3 pounds in 12-inch band on the row for tomato.

metham--Preplant soil treatment.
General range--160 to 400 pounds active/acre overall for fields and 300 to 400 pounds active/acre (1.5 to 2.0 pints/100 square feet) for seedbeds.

MBR--Preplant soil treatment.
General range--150 to 235 pounds (180 to 350 for tomato seedbeds) active/acre for seedbeds and plant beds. Expose to fumigation at least 24 hours (up to 48 hours). Aerate a minimum of 3 days before seeding or 5 to

14 days before setting vegetative growth. For broccoli, cantaloup, cauliflower, eggplant, muskmelon, pepper, and tomato.

oxamyl--Preplant soil treatment, at planting treatment, transplant water treatment, and foliar spray.
General range--2 to 4 pounds active/acre preplant broadcast, or 0.6 to 1.34 pounds preplant rows, or 0.5 to 1.0 pound as a foliar spray 2 to 4 weeks after planting and again 14 to 21 days later for cantaloup, honeydew melon, and watermelon; 4 to 8 pounds preplant broadcast or 2 to 4 pounds at planting in seed furrow for carrot, cucumber, and squash; 0.5 pound in 200 gallons of water during transplanting for bell pepper; 4 to 6 pounds preplant broadcast or 2 to 6 pounds in 200 gallons of transplant water for Swiss chard.

phenamiphos--Preplant soil treatment.
General range--4 to 6 pounds active/acre preplant overall or 1.5 to 3 pounds preplant in 12- to 15-inch band or row for brussels sprouts transplants and cabbage.

terbufos--At planting treatment.
General range--8 ounces active/1,000 linear feet of row in the seed furrow for sweet corn.

TABLES OF SUGGESTED NEMATICIDES USES

Nematicide information is arranged under crop headings that are arranged alphabetically under the following general categories: Field Crops, Flower and Ornamental Crops, Fruit and Nut Crops, Grass and Turf Crops, Oilseed and Industrial Crops, and Vegetable Crops. For an explanation of these tables, see page 10 of this guide.

FIELD CROPS

by

Lawrence D. Young, Gerald D. Griffin, and Calvin C. Orr

GENERAL FIELD CROP USES

The chemical listed in this section of the table can be considered for its use as a nematicide for preplant treatments in soil in which field crops are to be grown. General conditions of use of this nematicide are similar for all of these crops, and the nematicide does not require a tolerance. Other chemicals, listed under the various field crops, can also be considered for use as nematicides, but these require more specific conditions of use, or tolerances, or both. Consult local production specialists before proceeding with treatments.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
FIELD CROPS	1,3-D		90 - 250 240 - 600 45 - 100 90 - 200	Preplant overall in mineral soils. Preplant overall in muck soils. Preplant in rows, mineral soils. Preplant in rows, peat or muck soils.	Limit 600 lb/acre. After application and sealing, leave soil undisturbed for 7-14 days for lighter soils and up to 21 days for muck and peat soils. These periods must be extended prior to planting in case of heavy rains or temperatures below 60°F. To hasten aeration, especially if heavy rains or low temperatures occur, work the soil to the depth of the treatment zone. A minimum of 300 lb/acre on mineral soils for control of cyst nematodes, and a waiting period of 21-28 days.

END OF GENERAL STATEMENT

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
ALFALFA	1,3-D				See general statement.
BARLEY	1,3-D				See general statement.
BUCKWHEAT	1,3-D				See general statement.
CLOVER	1,3-D				See general statement.
CORN (FIELD)	Carbofuran		1.5 - 2.0/13,000 linear feet of row	At-planting in 7-15-inch band and incorporate into top 3 inches of soil.	Do not use more than 2.0 lb/13,000 linear ft of row as an at-planting row treatment.
	1,3-D				See general statement.
	Ethoprop		1.5 - 2.0 on 40-inch rows	Apply from 3 days before planting to at-planting in 12-15-inch band. Mix in top 2-4 inches of soil immediately after application.	Southeastern States only. Granular formulation only. Do not use as a seed furrow treatment.
			6.0	Broadcast from 3 days before planting to planting. Mix uniformly into top 2-4 inches of soil immediately after application.	
	Fensulfothion		2.0	Apply in 12-inch band over row in front of planter shoe. Incorporate 3 inches.	Southeastern States only. Do not place treated bands or furrows closer than 6 inches.
	Terbufos		0.5 - 1.0/1,000 linear ft of row	Apply in 7-inch band directly behind planter shoe in front of press wheel.	Cover granules that may be exposed on the ends of treated rows and turns and loading areas. Minimum 20-inch row spacing.
			0.5/1,000 linear ft of row	Apply directly in seed furrow behind planter shoe.	

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
CORN (POP)	1,3-D				See general statement.
	Fensulfothion		2.0	Apply in 12-inch band over row in front of planter shoe. Incorporate 3 inches.	Southeastern States only. Do not place treated bands or furrows closer than 6 inches.
	Terbufos		0.5 - 1.0/1,000 linear ft of row	Apply in 7-inch band directly behind planter shoe in front of press wheel.	Cover granules that may be exposed on the ends of treated rows and turns and loading areas. Minimum 20-inch row spacing.
			0.5/1,000 linear ft of row	Apply directly in seed furrow behind planter shoe.	
COTTON	Aldicarb		0.5 - 1.5 2.1 - 4.0 in Far West.	Apply at-planting in 4-6-inch band and work into the soil or cover with soil. If rate does not exceed 1.0 lb/acre drill granules just below seed line or place in seed furrow and cover with soil.	Do not make more than one nematicidal or insecticidal at-planting application and one post-emergence insecticidal application/crop. For Far West application plant seed above treated zone.
	1,3-D				See general statement.
	Fensulfothion		3.3 - 6.5	Apply in 12-inch band at-planting, but do not place treated zones closer than 6 inches. Thoroughly mix in top 4-6 inches of soil. Plant seed in center of treated band.	Southeastern and Gulf States only. Do not use foliage from treated fields for feed or forage.
	Phenamiphos		1 - 2.2	Apply in a 12-18-inch band over the row in front of the planter shoe. Use sufficient water with the emulsifiable concentrate. Incorporate to a depth of 2-6 inches.	Do not use band widths that will allow treated areas to overlap. Do not replant treated area with any food crop not specified on labels within 12 months after last application. Do not feed or graze cotton foliage and do not graze any cover crops within 12 months after last application.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
LESPEDEZA	1,3-D				See general statement.
MILLET	1,3-D				See general statement.
OATS	1,3-D				See general statement.
RICE	1,3-D				See general statement.
RYE	1,3-D				See general statement.
SUGAR BEETS	Aldicarb	90 120 if tops are to be fed to livestock.	4.0 - 5.0 on 22-inch row spacings.	Drill granules 1.5-3 inches to irrigation side of seed row and 2-4 inches deep at time of planting.	Do not exceed a total of 6 lb/acre/crop, including insecticidal applications. Do not make any post-emergence application if 4.0 or more lb/acre were used at-planting or within one week before planting. Do not make more than one at-planting and two post-emergence applications per crop. Do not use tops as food for humans.
			2.1 on 22-inch row spacings at-planting and post-emergence.	Apply at-planting as above. Apply post-emergence 40-60 days after planting 2-4 inches to irrigation side of row and 3-6 inches deep.	
			4.0 on 22-inch row spacing.	Apply post-emergence 4-8 inches to irrigation side of row and 3-6 inches deep.	
	1,3-D				See general statement.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
SUGARCANE	Aldicarb	120	2.0 - 3.0 on 60-inch row spacings.	Apply in opened row on top of newly planted cane and cover immediately with at least 6 inches of soil.	Louisiana only. One application/crop.
	Carbofuran		2.0 - 4.0 /8,500 linear feet of row.	Apply at-planting time in a 15-inch band directly over planted cane just before covering with soil. For stubble cane apply in a 15-inch band over the stubble row within 1-2 weeks following harvest and then cover with 1-2 inches of soil.	Do not use in Hawaii. Do not apply more than 4.0 lb/8,500 linear feet of row at-planting time or within 1-2 weeks following harvest.
	1,3-D				See general statement.
	Ethoprop		2.0 - 4.0 on 6-foot rows.	Apply in 12-15-inch band on the newly planted cane in the open furrow at-planting time. Mix with covering soil after application.	Louisiana only. Granular formulations.
	Fensulfothion		2.0 - 5.0 on 60-inch rows.	Apply in 12-18-inch band over newly planted cane in open furrow at-planting time.	Florida only. Do not place treated zones closer than 6 inches. Granular formulations only. For use only by commercial growers and applicators.
SORGHUM	1,3-D				See general statement.
TOBACCO	Carbofuran		6.0	Before forming beds, apply granules broadcast over soil surface and incorporate 4-6 inches. Form beds and plant as usual. or Apply granules in a 14-18-inch band over the bed and incorporate to a depth 4-6 inches. Reform beds and plant as ususal.	For flue-cured tobacco only. Use no more than 6.0 lb/acre.
	1,3-D				See general statement.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
TOBACCO (con.)	Ethoprop		6.0	Apply on 42-inch rows from 1 week before planting to at-planting time, in in 18-24-inch band. Mix into top 4-6 inches of soil immediately after planting.	
			6.0 - 8.0	Broadcast treatment.	
	Fensulfothion		4.0 - 6.0	Apply over 40-inch rows in 10-12-inch band for the lower rates; apply higher rate in a 16-inch band. Incorporate 4-6 inches in the soil.	Do not place treated zones closer than 6 inches. For use only by commercial growers and applicators.
			6.0 - 10.0	Broadcast treatment.	
	Fosthietan		1.5	Apply as a broadcast, preplant treatment. Spray evenly over soil surface and immediately incorporate 4-6 inches in the soil. Transplant seedlings within 3 weeks of treatment.	Make only one application per year. Do not use in tile-drained fields or seedbeds.
	Metham		3.1 - 4.8 lb/100 sq yd.	Cover with gas-proof plastic cover or tarpaulin for 24-48 hours. After 7 days cultivate to 2-inch depth.	For seedbeds. Do not seed earlier than 21 days after application. Do not apply within 3 ft of drip line or to areas underlain by roots of valuable plants.
			6.2 - 7.9 lb/100 sq yd.	Apply in 150 to 250 gallons of water. Seal by rolling and sprinkling. After 7 days cultivate to 2-inch depth.	For seedbeds. Fall treatment is preferable. To avoid injury to young tobacco, apply at least 21 days before seeding.
	MBR		343 - 870	Apply as preplant treatment under gas-proof cover for at least 48 hours.	Maximum 870 lb/acre. Aerate at least 2 days before seeding.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
TOBACCO (con.)	Oxamyl		4.0 - 6.0	Apply in 18-24-inch band over the row. Incorporate 4-6 inches.	Use only in commercial and farm plantings.
			0.312 - 0.5/ 5,600 to 9,000 plants.	Apply in minimum of 100 gallons of transplant water.	
			1.0/12,000 linear feet of row.	Apply in directed spray 2 weeks after transplanting. Repeat at 4-5 weeks after transplanting.	
TREFOIL (BIRDSFOOT)	1,3-D				See general statement.
VETCH	1,3-D				See general statement.
WHEAT	1,3-D				See general statement.

FLOWER AND ORNAMENTAL CROPS

by

Robert A. Dunn

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks

GENERAL FLOWER AND ORNAMENTAL CROP USES

The chemicals listed in the two general statements in this table are registered for nematicidal uses and can be considered for use for nematode control in the production of flower and ornamental crops. They may also have state registrations for local uses on additional crops. With a few exceptions, general conditions of use of these suggested nematicides do not differ among the various plant species. Therefore, such information, and precautions to be observed for each nematicide, are listed only once in one of the two general statements below. Uses suggested for specific crops refer to the information in the general statements.

GENERAL SOIL FUMIGANT NEMATICIDE STATEMENT

Soil fumigant nematicides are registered for preplant treatments of field soils, nursery soils, and soil mixes. Many of these fumigants can be used to reduce additional soilborne problems, such as fungi, insects, and weeds, depending on dosage rates and methods of application. Check labels of individual products for details, and consult with local production specialists regarding specific dosage rates, conditions of use, and methods of application before using any of these nematicides.

FLOWER AND ORNAMENTAL CROPS	Chloropicrin		468 - 1,038	Preplant fumigation; when soil is to be sealed with water or by cultipacking.	Exposure period 24-48 hours. Aerate 7 to 14 days before planting. Maximum 1,076 lb active/acre.
			145 - 193	Preplant overall fumigation; when sealing with plastic or other gas-proof cover.	
			3 - 4 cu cm/sq ft	Preplant fumigation of greenhouse beds and potting soil with plastic tarp or other gas-proof seal.	Maximum 1 lb active/cu yd.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
SHALLOW-ROOTED ORNAMENTALS AND FLORAL CROPS	1,3-D		84 - 140	Preplant for mineral soils, overall. For row treatment with a single chisel/row, increase rate/chisel by 1/3, per label.	Seal soil by compaction immediately after application. Leave soil undisturbed 7-14 days. Assure complete aeration of soil before planting, by shallow cultivation if necessary. Do not plant if odor of fumigant is still evident in the soil. Deep application, high rates, and wet or cold soils may require much longer for adequate aeration, up to 3-6 months.
			223 - 335	Preplant for muck or peat soils, overall; for row treatment, increase rate/chisel by 1/3, per label.	
DEEP-ROOTED ORNAMENTALS	1,3-D		140 - 950	Preplant for mineral soils, overall.	Rate depends on depth of treatment and soil texture. See precautions above.
POTTING SOIL	Metham		0.65 lb active/ cubic yard.	Preplant overall.	Sprinkle specified solution over surface of 4-inch layer of soil or mechanically mix metham with soil in a mixer or shredder. To seal soil, sprinkle surface of finished pile with water or cover with plastic or other tarp. Allow soil to aerate and dry thoroughly before use; if in doubt, plant a few seedlings in treated soil to observe for toxicity before using it.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
SEEDBEDS, PLANT BEDS	Metham		124 - 505	Preplant treatment.	Rates depend on method and depth of application. Metham can be applied via chisels spaced 5 inches apart, sprinkler or flood irrigation, drenching via sprinkler can or hose-end applicator and incorporation by rototiller. Activity, especially against soilborne disease and weeds, is better with use of plastic tarp or similar seal after treatment. It may be necessary to aerate soil 5-7 days after application. Plant 14-21 days after treatment of light to medium soils. Wet, cold, heavy soils require longer between treatment and planting. Plant seedlings in treated soil to observe for phytotoxicity if in doubt about adequacy of aeration.
FLOWERS, SHADE TREES, ORNAMENTAL SHRUBS AND VINES	MBR		1 - 2 lb/100 sq ft (equivalent to 427 - 871 lb/acre)	Preplant overall treatment of plant beds and planting sites.	Low rate for control of only nematodes, higher rates for control of additional soil-borne pests. Soil surface must be sealed immediately with a plastic tarp.
			0.5 - 1 lb/cubic yard	Preplant fumigation of compost and potting soil.	CAUTION for all sites; MBR may be toxic to carnations, holly, delphiniums, snapdragons and certain other crops. Consult local authorities before using.

END OF GENERAL SOIL FUMIGANT NEMATICIDE STATEMENT

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks

GENERAL NON-FUMIGANT NEMATICIDE STATEMENT

Non-fumigant, or contact, nematicides are registered for certain uses on various flower and ornamental crops. Included in these are preplant and postplant treatments for plant beds, soil in benches, plants in containers, bare-root and tuber dips, field soils, and nursery stock in general. Many of these chemicals are registered also for control of insects and other arthropod pests under certain conditions. Check labels of individual products for details, and consult with local production specialists regarding specific dosage rates, conditions of use, and methods of application before using any of these nematicides. Check with local production specialists regarding specific dosage rates, conditions of use, and methods of application before using any of these nematicides.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
ORNAMENTALS	Ethoprop		0.37 lb/50 gal water	Bare root and tuber dip at planting.	Dip washed roots of plants in mixture specified on the label so that only the roots are covered: allow to soak for 30 minutes before planting: rate and soak time are reduced for leatherleaf fern. TREATED PLANTS SHOULD BE LABELED, "Warning. Wear rubber gloves when handling treated plants."
			0.37 lb/50 gal water	Postplant pot drench.	Pour enough of mixture specified on label to completely drench the soil (about 0.5 pint per 6-inch pot, 1 pint per 8-inch pot). Wash mixture from foliage immediately to avoid plant injury. Rate is reduced for leatherleaf fern.
			0.37 to 0.75 lb/ 1,000 sq ft	Postplant bed and bench treatment.	Apply uniformly to area; wash mixture from foliage immediately. After application, apply enough water to soak chemical 4-6 inches into the soil. Rate is reduced for leatherleaf fern.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
ORNAMENTALS (con.)	Ethoprop (con.)		0.37 lb/100 gal water	Postplant field nursery stock treatment.	Evenly apply mixture specified on label to the desired area; wash mixture from foliage immediately to avoid plant injury. Apply enough additional water to wet the soil to a depth of 6-12 inches, depending upon depth of roots. NOTE: If plants other than those mentioned on the label are to be treated, only a few should be treated until effects on the plant can be evaluated; some plants or varieties may show temporary growth retardation after treatment.
	Fensulfothion		1 lb/1,000 sq ft	Preplant treatment of beds and benches.	Apply evenly over area; work thoroughly into soil to a depth of 4-6 inches; do not apply to a newly-seeded area.
			1.4 grams/cubic ft	Preplant treatment of potting soil.	Thoroughly mix 1/3 oz of 15% granular formulation into 1 cubic foot of soil. TO BE USED ONLY OUTDOORS. DO NOT TREAT peony, begonia, hydrangea, or Aucuba spp. because of possible plant injury.
	Oxamyl		6 - 8	Preplant soil treatment for field grown plants.	Apply liquid in a minimum of at least 20 gal of water/acre; distribute granules uniformly. Incorporate 4-8 inches deep with a rotary tiller.
			Variable see label	Foliar treatment for field grown plants.	Mix in 100 gal water, apply as a dilute spray, applying no more than 200 gal spray/acre. Apply on a 2-3-week schedule for 4 applications, beginning when plants are in first full leaf or when plant is growing actively. Include a spreader sticker.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
ORNAMENTALS (con.)	Oxamyl (con.)		Variable see label	Preplant, soil mix treatment.	Apply specified amount of granules or solution specified on label to soil while tumbling soil in a mixer.
			Variable see label	Postplant, potted plants.	Drench with solution on label at 4-8 fluid oz/6-inch pot or 2-4 fluid oz/4-inch pot, or uniformly apply specified rate of granules to surface of potting medium and follow with 1 inch of overhead irrigation to thoroughly wash granules from foliage and move active ingredient into soil.
			Variable see label	Root, corm, or bulb dip.	Place plant material in label-specified solution for 1-30 minutes using higher concentrations of oxamyl and longer soaking times for more severe infestations. NOTE: Since different varieties of ornamentals may respond differently to oxamyl, any treatment should first be tested on a small scale; varietal response may also be affected if oxamyl is mixed with other products.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
NURSERY STOCK	Phenamiphos		18.0	Postplant.	Apply uniformly to the area. Irrigate immediately after treatment using a minimum of 1/2 inch of water. Do not apply more than once/year per planting site. Do not consume fruit or nuts from treated plants. If nursery stock other than those listed are to be treated, treat a few plants first and observe for phytotoxicity before treating on a large scale. Workers shall not enter treated areas within 48 hours after completion of an application unless impervious boots and gloves are worn. In addition, for a 7-day period following completion of an application, impervious gloves and boots must be worn when entering treated fields that are muddy.

END OF GENERAL NON-FUMIGANT NEMATICIDE STATEMENT

Non-fumigant pesticides registered for specific nematicidal uses, including treatment of live plants; most are also registered for treatment of insects, or other arthropod pests under some circumstances.

AFRICAN VIOLET (Saintpaulia spp.)	Oxamyl				See general statement/ornamentals.
AGERATUM, FLOSSFLOWER, (Ageratum spp.)	Oxamyl				See general statement/ornamentals.

FLOWER AND ORNAMENTAL CROPS

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
AGLAONEMA, CHINESE EVERGREEN (Aglaonema spp.)	Ethoprop				See general statement/ ornamentals.
AJUGA (Ajuga metallica)	Phenamiphos				See general statement/ ornamentals.
ALLSPICE (Calycanthus floridus)	Oxamyl				See general statement/ ornamentals.
ALOE, MEDICINE PLANT (Aloe spp.)	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
ALYSSUM (Lobularia spp.)	Oxamyl				See general statement/ ornamentals.
ANTHURIUM (Anthurium spp.)	Phenamiphos		3.4 - 7.0 1.25 - 2.6 oz/ 1,000 sq ft.	Preplant broadcast.	Apply uniformly to the area. Irrigate immediately after treatment using a minimum of 1/2 inch of water. Do not apply more than twice in any one 12-month period.
APPLE (Malus spp.)	Oxamyl				See general statement/ ornamentals.
ARBORVITAE (Thuja occidentalis)	Oxamyl				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
ARDISIA (Ardisia spp.)	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
ARECA PALM (Areca sp.)	Oxamyl				See general statement/ ornamentals.
ARTILLERY PLANT (Pilea microphylla)	Oxamyl				See general statement/ ornamentals.
ASPARAGUS FERN (Asparagus sprengeri)	Oxamyl				See general statement/ ornamentals.
AZALEA (Rhododendron spp.)	Ethoprop				See general statement/ ornamentals.
	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ ornamentals.
BARBERRY (Berberis thunbergii)	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
RIEGER BEGONIA (Begonia spp.)	Oxamyl				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
BLUE MIST	Fensulfothion				See general statement/ ornamentals.
(*Bougainvillea* spp.)	Fensulfothion				See general statement/ ornamentals.
BOXWOOD (*Buxus* spp.)	Ethoprop				See general statement/ ornamentals.
	Fensulfothion				See general statement/ ornamentals.
	Phenamiphos				See general statement/ ornamentals.
BROMELIADS	Ethoprop				See general statement/ ornamentals.
BROOM (*Cytisus purpureus*)	Oxamyl				See general statement/ ornamentals.
BUCKEYE (*Aesculus splendens*)	Oxamyl				See general statement/ ornamentals.
BUCKTHORN TALLHEDGE (*Rhamnus frangula*)	Oxamyl				See general statement/ ornamentals.
BUTTERFLY IRIS	Fensulfothion				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
CACTUS (*Cactus* spp.)	Ethoprop				See general statement/ ornamentals.
	Phenamiphos				See general statement/ ornamentals.
(*Schlumbergera bridgesii*)	Oxamyl				See general statement/ ornamentals.
CALADIUM (*Caladium* spp.)	Ethoprop				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
CALATHEA (*Calathea* sp.)	Oxamyl				See general statement/ ornamentals.
CALENDULA (*Calendula* sp.)	Oxamyl				See general statement/ ornamentals.
CAMELLIA (*Camellia* spp.)	Ethoprop				See general statement/ ornamentals.
	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
CARNATION (*Dianthus* spp.)	Oxamyl				See general statement/ ornamentals.
CENTURY PLANT (*Agave* spp.)	Fensulfothion				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
CHERRY, FLOWERING (*Prunus* spp.)	Phenamiphos				See general statement/ ornamentals.
CHRYSANTHEMUM (*Chrysanthemum* spp.)	Demeton		0.25 - 0.5/50 gal of water.	Foliar spray or soil drench. Apply as spray and thoroughly wet foliage. Apply as soil drench 1 pint of diluted solution/square foot of bed or bench.	This chemical is systemic. It penetrates by absorption and is translocated in the plant. Do not apply within 5 days of hand picking, pruning, transplanting, or other handling. For control of foliar nematodes.
			0.25 pint of the 0.25/50 gallons dilution/6-inch pot.	Postplant for potted plants. Apply at 7-14-day intervals for as many as three applications.	
			0.25 pint of the 0.5/50 gallons dilution/6-inch pot.	Postplant for potted plants. Apply at 14-21-day intervals for as many as three applications.	CAUTION: Croft lilies have shown phytotoxicity on occasion; care should be exercised when treating these plants.
	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
CITRUS (*Citrus* spp.)	Oxamyl				See general statement/ ornamentals.
CLEMATIS (*Clematis* spp.)	Phenamiphos				See general statement/ ornamentals.
COLEUS (*Coleus* sp.)	Oxamyl				See general statement/ ornamentals.
COPPERLEAF (*Acalypha wilkesiana*)	Oxamyl				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
COTONEASTER (Cotoneaster spp.)	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ ornamentals.
CRAPE MYRTLE (Lagerstroemia indica)	Oxamyl				See general statement/ ornamentals.
CROTON (Codiaeum spp.)	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
CYCLAMEN (Cyclamen spp.)	Fensulfothion				See general statement/ ornamentals.
CYPRESS (CEDAR) (Chamaecyparis spp.)	Oxamyl				See general statement/ ornamentals.
DAFFODILS (Narcissus spp.)	Demeton				See chrysanthemum/demeton.
DEVIL'S IVY, POTHOS (Scindapsus aureus)	Ethoprop				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
DEVILWOOD, CHINESE HOLLY (Osmanthus heterophyllus)	Oxamyl				See general statement/ ornamentals.

FLOWER AND ORNAMENTAL CROPS

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
DIEFFENBACHIA (*Dieffenbachia* spp.)	Oxamyl				See general statement/ ornamentals.
DOUGLAS-FIR (*Pseudotsuga menziesii*)	Oxamyl				See general statement/ ornamentals.
DRACAENA (*Dracaena* spp.)	Oxamyl				See general statement/ ornamentals.
ELM, CHINESE (*Ulmus parvifolia*)	Oxamyl				See general statement/ ornamentals.
EUONYMUS (*Euonymus* spp.)	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ ornamentals.
EURYA (*Eurya japonica*)	Fensulfothion				See general statement/ ornamentals.
FERN, many genera and species; see also leatherleaf fern	Ethoprop				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
FIG, many (*Ficus* spp.)	Oxamyl				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
FIR (*Abies lasiocarpa*)	Oxamyl				See general statement/ ornamentals.
FIRETHORN (*Pyracantha* spp.)	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ ornamentals.
FLOWERING CRAB (*Malus* spp.)	Phenamiphos				See general statement/ ornamentals.
FUCHSIA (*Fuchsia* spp.)	Oxamyl				See general statement/ ornamentals.
GALLBERRY (*Ilex glabra*)	Fensulfothion				See general statement/ ornamentals.
GARDENIA (*Gardenia* spp.)	Ethoprop				See general statement/ ornamentals.
	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ ornamentals.
GAZANIA (*Gazania* spp.)	Oxamyl				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
GERANIUM (Geranium spp.)	Oxamyl				See general statement/ ornamentals.
GERBERA, TRANSVAAL DAISY (Gerbera jamesonii)	Oxamyl				See general statement/ ornamentals.
GINKGO (Ginkgo biloba)	Oxamyl				See general statement/ ornamentals.
GLADIOLUS (Gladiolus spp.)	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
(Gloxinia spp.)	Fensulfothion				See general statement/ ornamentals.
GOLD DUST TREE (Aucuba spp.)	Oxamyl				See general statement/ ornamentals.
GYPSOPHILA OR BABY'S BREATH (Gypsophila spp.)	Oxamyl				See general statement/ ornamentals.
HEMLOCK (Tsuga canadensis)	Oxamyl				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
HIBISCUS (*Hibiscus* spp.)	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ ornamentals.
HOLLY (*Ilex* spp.)	Ethoprop				See general statement/ ornamentals.
	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ ornamentals.
HONEYSUCKLE (*Lonicera* spp.)	Fensulfothion				See general statement/ ornamentals.
HOYA OR HINDU ROPE (*Hoya carnosa*)	Oxamyl				See general statement/ ornamentals.
(*Hypericum* spp.)	Oxamyl				See general statement/ ornamentals.
IMPATIENS (*Impatiens sultanii*)	Oxamyl				See general statement/ ornamentals.
IRIS (*Iris* spp.)	Oxamyl				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
IRIS BULBS (*Iris* spp.)	Phenamiphos				See lily bulbs/phenamiphos.
IRIS BUTTERFLY	Fensulfothion				See general statement/ ornamentals.
IXORA (*Ixora coccinea*)	Oxamyl				See general statement/ ornamentals.
IVY (*Hedera helix baltica*)	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ ornamentals.
JADE PLANT (*Crassula* spp.)	Oxamyl				See general statement/ ornamentals.
JASMINE (*Jasminum* spp.)	Fensulfothion				See general statement/ ornamentals.
JASMINE, WAX (*Jasminum volubile*)	Oxamyl				See general statement/ ornamentals.
JUNGLE FLAME (*Ixora coccinea*)	Fensulfothion				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
JUNIPER (*Juniperus* spp.)	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ ornamentals.
KALANCHOE (*Kalanchoe* spp.)	Oxamyl				See general statement/ ornamentals.
LANTANA (*Lantana* spp.)	Oxamyl				See general statement/ ornamentals.
LEATHERLEAF FERN (*Rumohra adiantiformis*)	Oxamyl				See general statement/ ornamentals.
	Phenamiphos		10	Postplant broadcast.	Apply uniformly to the area. Irrigate immediately after treatment using a minimum of 1/2 inch of water.
LEUCOTHOE DOGHOBBLE, SWITCH IVY (*Leucothoe* spp.)	Oxamyl				See general statement/ ornamentals.
LILIES, BULBS	Aldicarb		5 - 7 on 40-inch row spacing.		Apply in furrow with bulblet at planting time; cover with soil. For lesion nematodes.
LILIES	Demeton				See chrysanthemum/demeton.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
LILY BULBS (*Lilium* spp.)	Phenamiphos		6 - 12 on 42-inch row spacing or 0.435 - 0.95 lb/ 1,000 feet of row.	In furrow at-planting so that material is incorporated into the covering soil, or in a 10-12-inch band over the row after planting. Postplant on year-old plantings over the row as a fall application in October, November, or December.	Incorporate with irrigation or rainfall as soon as possible after application.
	Phorate		10 - 16	At-planting time: 1/2 dose applied under or on the lily bulb, 1/2 dose on soil on top of lily bulb. Apply as evenly as possible.	RESTRICTED USE: This chemical is systemic. For control of root lesion nematodes in Pacific Northwest only. For use in the production of commercially grown bulbs only. Not for home garden use. For Easter lily only. For use by licensed applicator only.
LILIES (*Hosta grandiflora*)	Phenamiphos				See general statement/ nursery stock.
EASTER LILY (*Lilium longiflorum*)	Fensulfothion				See general statement/ ornamentals.
MAGNOLIA (*Magnolia* spp.)	Oxamyl				See general statement/ ornamentals.
MAHONIA (*Mahonia* spp.)	Fensulfothion				See general statement/ ornamentals.
SUGAR MAPLE (*Acer saccharum*)	Oxamyl				See general statement/ ornamentals.
MARIGOLDS (*Tagetes* spp.)	Oxamyl				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
(*Metrosideros* spp.)	Fensulfothion				See general statement/ ornamentals.
MOCK ORANGE (*Deutzia scabra*)	Oxamyl				See general statement/ ornamentals.
MOSS ROSE (*Portulaca grandiflora*)	Oxamyl				See general statement/ ornamentals.
MULBERRY (*Callicarpa* spp.)	Oxamyl				See general statement/ ornamentals.
NARCISSUS BULBS (*Narcissus* spp.)	Phenamiphos				See lily bulbs/phenamiphos.
NATAL PLUM (*Carissa grandiflora*)	Fensulfothion				See general statement/ ornamentals.
NEPHTHYTIS, ARROWHEAD PLANT (*Syngonium podophyllum*)	Oxamyl				See general statement/ ornamentals.
NERVE PLANT (*Fittonia* spp.)	Oxamyl				See general statement/ ornamentals.
NORFOLK ISLAND PINE (*Araucaria excelsa*)	Oxamyl				See general statement/ ornamentals.
OLEANDER (*Nerium oleander*)	Oxamyl				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
ORCHIDS, several genera, see label	Oxamyl				See general statement/ ornamentals.
(*Osmanthus* spp.)	Fensulfothion				See general statement/ ornamentals.
PACHYSANDRA (*Pachysandra* spp.)	Phenamiphos				See general statement/ nursery stock.
(*Pachystachus* spp.)	Oxamyl				See general statement/ ornamentals.
PALMS: **NEANTHEBELLE** (*Chamaedorea elegans*)	Oxamyl				See general statement/ ornamentals.
MADAGASCAR (*Chrysalidocarpus lutescens*)	Oxamyl				See general statement/ ornamentals.
ROYAL (*Roystonea* spp.)	Oxamyl				See general statement/ ornamentals.
CHRISTMAS (*Veitchia merillii*)	Oxamyl				See general statement/ ornamentals.
PANSY (*Viola tricolor*)	Oxamyl				See general statement/ ornamentals.
PEAR	Oxamyl				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
PELLIONIA, SATIN (Pellionia pulchra)	Oxamyl				See general statement/ ornamentals.
PEPEROMIA (Peperomia spp.)	Oxamyl				See general statement/ ornamentals.
PERIWINKLE (Vinca minor)	Oxamyl				See general statement/ ornamentals.
(V. rosea)	Phenamiphos				See general statement/ nursery stock.
PETUNIA (Petunia spp.)	Oxamyl				See general statement/ ornamentals.
PHILODENDRON (Philodendron spp.)	Ethoprop				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
PIERIS (Pieris japonica, P. floribunda)	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ nursery stock.
PILEA (Pilea spp., including P. involucruta, P. floribunda, P. aluminum)	Oxamyl				See general statement/ ornamentals.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
PINE (*Pinus* spp.)	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ nursery stock.
PITTOSPORUM, JAPANESE (*Pittosporum tobira*)	Oxamyl				See general statement/ ornamentals.
FLOWERING PLUM (*Prunus* spp.)	Oxamyl				See general statement/ ornamentals.
PLUSH VINE (*Mikania ternata*)	Oxamyl				See general statement/ ornamentals.
PODOCARPUS (*Podocarpus* spp.)	Oxamyl				See general statement/ ornamentals.
POINSETTIA (*Euphorbia pulcherrima*)	Oxamyl				See general statement/ ornamentals.
POLKA DOT PLANTS (*Hypoestes* spp.)	Oxamyl				See general statement/ ornamentals.
POTHOS					See devil's ivy.
PRAYER PLANT (*Maranta kirchoviana*)	Oxamyl				See general statement/ ornamentals.
PRIMROSES	Demeton				See chrysanthemum/demeton.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
PRIVET (*Ligustrum* spp.)	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ nursery stock.
PURPLE PASSION (*Gynura sarmentosa*)	Oxamyl				See general statement/ ornamentals.
RHODODENDRON (*Rhododendron* spp.)	Phenamiphos				See general statement/ nursery stock.
ROSE (*Rosa* spp.)	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ nursery stock.
SALVIA (*Salvia spendens*)	Oxamyl				See general statement/ ornamentals.
SEA GRAPE (*Coccoloba uvifera*)	Oxamyl				See general statement/ ornamentals.
SEDUM (*Sedum* spp.)	Phenamiphos				See general statement/ nursery stock.
SNAKE PLANT (*Sansevieria* spp.)	Ethoprop				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.

FLOWER AND ORNAMENTAL CROPS

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
SNAPDRAGON (*Antirrhinum* spp.)	Oxamyl				See general statement/ ornamentals.
SPIRAEA (*Spiraea* spp.)	Oxamyl				See general statement/ ornamentals.
SPRUCE (*Picea* spp.)	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ nursery stock.
STATICE (*Limonium latifolium*)	Oxamyl				See general statement/ ornamentals.
STRAWBERRY GERANIUM (*Saxifraga sarmentosa*)	Oxamyl				See general statement/ ornamentals.
SURINAM CHERRY (*Eugenia uniflora*)	Fensulfothion				See general statement/ ornamentals.
TI PLANT (*Cordyline terminalis*)	Oxamyl				See general statement/ ornamentals.
VERBENA (*Verbena* spp.)	Oxamyl				See general statement/ ornamentals.
VIBURNUM (*Viburnum* spp.)	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ nursery stock.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
WANDERING JEW (Tradescantia sp.)	Oxamyl				See general statement/ ornamentals.
YAUPON, DWARF (Ilex vomitoria)	Fensulfothion				See general statement/ ornamentals.
SPIRAEA (Spiraea spp.)	Oxamyl				See general statement/ ornamentals.
YEWS (Taxus spp.)	Ethoprop				See general statement/ ornamentals.
	Fensulfothion				See general statement/ ornamentals.
	Oxamyl				See general statement/ ornamentals.
	Phenamiphos				See general statement/ nursery stock.
YUCCA (Yucca spp.)	Phenamiphos				See general statement/ nursery stock.

FRUIT AND NUT CROPS

by

E. J. Wehunt

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks

GENERAL FRUIT AND NUT CROP USES

The chemicals listed in this section of the table can be considered for their use as nematicides for preplant treatments in soil in which fruit and nut crops are to be grown. General conditions of use of these nematicides are similar for all these crops, and the nematicides do not require tolerances. Other chemicals, listed under the various fruit and nut crops, can also be considered for use as nematicides, but these require more specific conditions of use or tolerances, or both. Consult local production specialists before proceeding with treatments.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
FRUIT AND NUT CROPS	Chloropicrin	--	455 - 1,068	Apply overall 7-14 days before planting by injection 6 in deep with chisels on 10- to 12-in centers. Seal the soil immediately and leave undisturbed for 1 week. Cultivate the soil 1 week before planting to ensure dissipation of the chemical.	Do not apply within 10 ft of living plants.
	1,3-D	--	70 - 2,000	Apply in rows or overall before planting when soil temperature is between 40 and 80°F by injection 6 to 8 in deep with chisels on 10- to 12-in centers. Seal the soil immediately. Cultivate the soil after 7-14 days to ensure dissipation of the chemical. Wait 1 week for each 100 lb applied; 3 to 6 months for deep-rooted shrubs and trees.	Do not treat near living plants. Preplant treatment only.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
FRUIT AND NUT CROPS	MBR	730 (24 months)	1 - 2/100 sq ft	Apply to tree sites 14-37 days before planting when temperature is above 60°F by injecting 36 in deep with chisels or through tubes into backfilled excavated planting holes. Cover the treated area with a gas-proof tarp. Leave undisturbed for 7 days. Wait 7-30 days after removing tarp before planting.	Non-food use. Do not apply where trees or vines will bear fruit within 24 months. THIS IS A RESTRICTED-USE PESTICIDE.
			175 - 872	Apply in rows or overall 8-12 days before planting when soil temperature is above 60°F by releasing gas under sealed gas-proof tarp or inject 6 in into the soil with chisels on 12-in centers and cover immediately with a gas-proof tarp. Leave undisturbed for 24-48 hours before removing tarp. Wait 2-14 days after removing the tarp before planting.	Non-food use. Do not apply where trees or vines will bear fruit within 24 months. THIS IS A RESTRICTED-USE PESTICIDE.
	Metham		124 - 348	Apply to tree sites 14-21 days before planting when temperature is between 50 to 90°F by injection 4-10 in deep with injection shanks 5 in apart, or apply in water through sprinkler system or in basins using 3-18 inches of water.	Seal the soil immediately after application. A gas-proof tarp increases efficiency. Leave undisturbed for 5 to 7 days. Cultivate to ensure dissipation of chemical.

END OF GENERAL STATEMENT

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
ALMOND					See general statement for preplant nematicide. No nematicide is registered for postplant use.
APPLE					See general statement for preplant nematicide.
	Phenamiphos (except in California)	72	10 - 20	Apply in rows or overall preplant or postplant by spreading granules on the soil surface and incorporating immediately 2-4 in deep or by applying 1-2 in of water with sprinklers.	Do not graze livestock in or feed forage from treated areas.
	Oxamyl	365	6 - 8	Apply in rows or overall before planting by mixing the chemical with 20 gal of water and spraying onto the soil surface, followed by mechanical incorporation 4-6 in deep.	Non-food use.
		365	0.5 to 1/100 gal water.	Apply to active foliage after first full leaf by spraying to run-off 4 times at 2- to 3-week intervals. Include a spreader-sticker in the formulation.	Do not exceed 2 lb/acre/year. Do not apply to plants under stress. Non-food use.
		365	0.5 to 1/100 gal water.	Dip bare-rooted plants for 1-30 minutes and plant immediately.	Non-food use.
APRICOT					See general statement for preplant nematicide. No nematicide is registered for postplant use.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
BANANA	Carbofuran	--	0.04 - 0.09 oz/ plant/application	Apply in planting holes or postplant by placing 0.03 oz in bottom of planting hole and 0.02 oz on soil surface of filled hole. In established plantings apply 0.07-0.09 oz evenly to 20-in radius area around the plant.	See general statement for preplant nematicide. Do not use more than 0.09 oz/application. 0.01 p/m tolerance.
	Ethoprop	--	0.024 oz/plant	Apply to established plants to a 30-in radius area around plant by mixing with the top 2 in of soil or apply just before rain or irrigation.	Application may be repeated after 6 months. 0.02 p/m tolerance.
	Fensulfothion (Puerto Rico only).	60	0.15 - 0.22 oz/plant	Apply at-planting time or to established plants to a 24-30 inch radius area around plant by mixing with the top 2 in of soil.	Application may be repeated at 6-month intervals. 0.02 p/m tolerance.
BLACKBERRY					See general statement for preplant nematicide. No nematicide is registered for postplant use.
BLUEBERRY					See general statement for preplant nematicide. No nematicide is registered for postplant use.
BOYSENBERRY					See general statement for preplant nematicide. No nematicide is registered for postplant use.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
CHERRY	Oxamyl	--			See general statement for preplant nematicide.
	Phenamiphos (except in California).	45			Treatment as for apple.
CITRUS	Aldicarb	30	5 - 10	Apply at-planting time or postplant to both sides of tree row in bands equal to 1/4 the tree row spacing by spreading granules on the soil surface and incorporate immediately or apply by injecting 2-3 in deep into the soil using 4-6 shanks on 12-in centers.	See general statement for preplant nematicide. Make only one application per year. Do not graze livestock on treated areas. THIS IS A RESTRICTED-USE PESTICIDE.
	Ethoprop	--	6 oz in 50 gal water (900 p/m)	Dip bare-rooted plants for 30 minutes.	
	Fensulfothion	--	1 - 2 oz in 25 gal water.	Apply 0.33 pint to an 8-in pot as a drench.	
	Oxamyl				Treatment as for apple.
CURRANT					See general statement for preplant nematicide. No nematicide is registered for postplant use.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
DEWBERRY					See general statement for preplant nematicide. No nematicide is registered for postplant use.
FIG					See general statement for preplant nematicide. No nematicide is registered for postplant use.
GRAPE					See general statement for preplant nematicide.
	Carbofuran (California only)	--	10	Apply overall to soil surface between the vines between harvest and February. Incorporate immediately.	Do not use on soils of pH 8.0 or greater.
	Phenamiphos (except in California).	--	18	Apply in a band equal to 50% of area with row in middle of band.	Apply with injection equipment west of Rocky Mountains; apply to soil surface and incorporate immediately east of Rocky Mountains. Up to 3 applications can be made per season but do not exceed 18 lb/acre in one season. Do not graze or feed treated crop to livestock.
LOGANBERRY					See general statement for preplant nematicide. No nematicide is registered for postplant use.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
NECTARINE					See general statement for preplant nematicide. No nematicide is registered for postplant use.
PEACH					See general statement for preplant nematicide.
	Oxamyl				Treatment as for apple.
	Phenamiphos (except in California).				Treatment as for apple.
PEAR					See general statement for preplant nematicide.
	Oxamyl	365			Treatment as for apple.
PECAN					See general statement for preplant nematicide. No nematicide is registered for postplant use.
PINEAPPLE	Ethoprop	--	20 - 40	Apply overall from 3 weeks before planting time. Mix with the top 4 in of soil immediately after application.	See general statement for preplant nematicide. No nematicide is registered for postplant use.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
PLUMS AND PRUNES					See general statement for preplant nematicide. No nematicide is registered for postplant use.
QUINCE					See general statement for preplant nematicide. No nematicide is registered for postplant use.
RASPBERRY					See general statement for preplant nematicide. No nematicide is registered for postplant use.
STRAWBERRY					See general statement for preplant nematicide.
	Oxamyl			Foliar spray.	Treatment as for apple.
	Oxamyl			Dip bare root for 1-30 minutes.	Treatment as for apple.
WALNUT (English)					See general statement for preplant nematicide. No nematicide is registered for postplant use.

GRASS AND TURF CROPS

by

Julius Feldmesser and Lawrence D. Young

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks

GENERAL GRASS AND TURF USES

Several chemicals can be considered for their use as nematicides for preplant treatments in soil in which grass and turf are to be grown, or for postplant treatments as established grass and turf. General conditions of use of these nematicides are similar for all these grasses, and the nematicides do not require tolerances. Specific conditions of use or tolerances, or both, should be checked with local specialists before treatments are applied.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
GRASS AND TURF CROPS	Chloropicrin		480 - 635	Preplant overall for field.	Exposure period 24 to 48 hours.
			0.5 - 1.5/cubic yard.	Preplant for bulk soils.	Aerate 7-14 days before planting. Max. 1,076 lb/acre.
	1,3-D		160 - 486	Preplant overall.	Overall treatment is 150 to 200 lb/acre on mineral soil (300 lb/acre for cyst nematodes), 400 to 600 lb/acre on peat or muck. Wait 7 days before planting for each 100 lb applied, longer in case of heavy rains or temperatures below 60°F. To hasten aeration, especially if heavy rains or low temperatures occur during exposure period, work the soil to the depth of the treatment zone.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
GRASS AND TURF CROPS (con.)	Diazinon		40 - 54	Postplant overall.	For use on turf and lawns for the control of sting nematodes, lance nematodes, ring nematodes, spiral nematodes, stylet nematodes, sheathoid nematodes, and pin nematodes. Do not graze livestock in treated areas. Keep children and pets off grass until spray is completely dry. Apply evenly over surface. Water in with 0.5 to 1 acre-inch of water immediately afterward.
	Ethoprop		10 - 30	Overall treatment for established turf. Follow with 1.0 inch of water.	For control of sting nematodes and other plant-parasitic nematodes on commercial and residential turf, such as bahiagrass, bermudagrass, centipedegrass, St. Augustine grass, and zoysia grass by licensed applicators. Do not use on newly seeded areas until grass is well established. Do not cut or handle sod or turf for 21 days after treatment.
	Fensulfothion		11 - 22	Preplant, postplant overall.	For use by commercial growers and applicators only. Do not treat newly seeded areas. Do not cut or handle sod for 30 days after treatment. Do not use in or near human dwellings. This material kills by contact; therefore, mix it with soil to obtain maximum control. Preplant and postplant use: apply 0.25 to 0.5 inch of water to drench thoroughly after treatment. Not for home lawns and school yards.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
GRASS AND TURF CROPS (con.)	Metham		233 - 347	Preplant overall.	For lawn seedbeds, sprinkling can, hose proportioner, and soil injection. Seal with 1 inch of water. Plant 14 to 21 days after treatment where well-drained, light to medium-textured soils have not remained excessively wet or below 60°F following application. An interval of at least 30 days should be observed if soils are heavy, high in organic matter, or remain wet and cold. To promote drying and escape of vapors, lightly cultivate heavy wet soils, 5 to 7 days after application. Do not apply within 3 feet of drip lines or to areas underlain by roots of valuable plants.
	MBR		1 - 2 per 100 sq ft	Preplant overall.	Expose 24 to 48 hours under gas-proof tarp. Aerate for at least 2 days before seeding or 6 to 10 days before setting plants.
	Phenamiphos	12 months	0.225 - 0.45/ 1,000 sq ft.	Postplant overall.	For bermuda, centipede, bentgrass, bluegrass on golf courses, cemeteries, sod farms, industrial grounds, parkways and roadways only. Do not use on residential lawns or public recreation areas other than golf courses. Do not treat newly seeded areas. Do not graze livestock in treated areas or feed clippings. Do not replant treated area with any food crop not specified on label within 12 months after last application.

OILSEED AND INDUSTRIAL CROPS

by

Dale I. Edwards and Norman A. Minton

<table>
<tr><th>Crop</th><th>Nematicide</th><th>Min. days from last application to harvest or feeding</th><th>Pounds of active ingredient to apply per acre unless otherwise indicated</th><th>Where and when to apply</th><th>Safety restrictions and remarks</th></tr>
<tr><td colspan="6">GENERAL OILSEED AND INDUSTRIAL CROP USES
The chemicals listed in this section of the table can be considered for their use as nematicides for preplant treatments in soil in which all oilseed and industrial crops are to be grown. General conditions of use of these nematicides are similar for all of these crops, and the nematicides do not require tolerances. Other chemicals, listed under the various oilseed and industrial crops, can also be considered for use as nematicides, but these require more specific conditions of use, or tolerances, or both. Consult local production specialists before proceeding with treatments.</td></tr>
<tr><td>**OILSEED AND INDUSTRIAL CROPS**</td><td>Chloropicrin</td><td></td><td>480 - 1,076</td><td>Preplant overall without tarp.</td><td>Soil application to large areas may be made by plow-sole or chisel applicators in uniform streams 10-12 inches apart and at least 6 inches deep. After chisel application, soil should be sealed immediately by rolling or cultipacking. Following plow application, soil should be disked immediately, then rolled or cultipacked. For small areas a fumigun may be used which injects measured amounts on 8-, 9-, or 10-inch centers. To seal in the fumigant, treated areas should be covered with a gas-proof plastic cover or sprinkled with water to wet the soil to 1/2 to 1 inch depth.
Treated soil should be left undisturbed for a 24-48-hour exposure period. After the exposure period, the plastic cover should be removed and the soil aerated for 7-14 days before planting, longer if the soil temperature is low or soil moisture high. Precaution: Do not apply near buildings inhabited by humans, livestock, or poultry or near fields where leafy crops are growing.</td></tr>
</table>

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
OILSEED AND INDUSTRIAL CROPS	1,3-D		90 - 250	Preplant overall in mineral soils.	Limit 600 lb/acre. After application and sealing, leave soil undisturbed 7-14 days for lighter soils and up to 21 days for muck and peat soils. These periods must be extended prior to planting in case of heavy rains or temperatures below 60°F. To hasten aeration, especially if heavy rains or low temperatures occur, work the soil to the depth of the treatment zone. A minimum of 300 lb/acre on mineral soils for control of cyst nematodes, and a waiting period 21-28 days.
			240 - 600	Preplant overall in muck soils.	
			45 - 100	Preplant in rows, mineral soils.	
			90 - 200	Preplant in rows, peat or muck soils.	
	Metham		160 - 400	Preplant overall for fields.	For soil injection or flood irrigation, plastic cover can be used; keep in place 24-48 hours. Wait at least 21 days before planting, 30 days at low temperature or at high rates of application. Do not apply within 3 feet of drip line or to areas underlain by roots of valuable plants.

END OF GENERAL STATEMENT

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
FLAX					See general statement.
HOPS					See general statement.
MINT					See general statement.
PEANUT	Aldicarb		2.1 - 3.0 in 36-inch row.	Apply uniformly over seed row in 6-12-inch band at planting time. Work into the soil or cover with soil to a depth of 2-4 inches. Plant seed in treated zone.	Do not make more than one application per crop. Do not hog off treated fields or feed hay or vines to livestock.
	Carbofuran		2 - 4 in 36-inch row	12-inch wide band.	Do not feed treated peanut forage to dairy animals or animals being finished for slaughter.
			3 - 5 in 36-inch row	18-inch wide band. Apply uniformly over seed row prior to planting. Work into soil to a depth of 3 inches.	
	Ethoprop		3 - 4 in 36-inch row	Apply in 15-18-inch band on the row.	Do not use as a seed furrow treatment.
			2 in 36-inch row	Apply in 12-inch band on row. Apply from one week before planting to at-planting. Work into the soil to a depth of 4 inches.	
			3 in 36-inch row	Apply in 15-18-inch band on the row at pegging and incorporate lightly into the soil.	

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
PEANUT (con.)	Fensulfothion		3 - 6	At-plant overall. Work into the soil to a depth of 4-6 inches.	Do not feed vines or hay. Do not exceed the stated broadcast rate per acre, no matter how the pesticide is applied. When planting or when other applications of fensulfothion are made do not apply more than 7.0 lb/acre total for any crop year.
			2 - 4 in 36-inch row	Apply in 12-18-inch band on the row at-planting time or as an early season suppressant. Work into the soil to a depth of 4-6 inches.	
	Oxamyl		1 - 3	Apply in 7-12-inch band. Incorporate with a rotary tiller to a depth of 3 inches at-planting. Use the higher rate and wider band for severe nematode and insect infestation.	Apply only as directed. Make no additional applications of oxamyl.
			1 - 2	Apply as foliar spray. Foliar treatment is to be used only following soil fumigation, or following preplant or at-planting soil application of oxamyl or other contact nematicides.	
	Phenamiphos		3 - 5	At-plant overall. Work into the soil to a depth of 2-6 inches.	Do not feed or graze peanut vines or peanut vine hay. Do not hog down treated peanut field. Do not exceed the stated broadcast rate regardless of how the pesticide is applied.
			1.5 - 2.5 in 36-inch band.	Apply in 12-18-inch band on the row in front of planter at-planting time. Use high rate in fields with history of high nematode populations. Work into the soil to a depth of 2-6 inches.	
SAFFLOWER					See general statement.
SESAME					See general statement.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
SOYBEAN	Aldicarb	90	1.5 - 3.0 on 36-inch rows; or 1.65 - 3.3 oz/1,000 linear feet of row on 30-48-inch row spacings.	Apply at-planting in 6-8-inch band and work into soil to a depth of 2-4 inches. Plant seed in treated zone.	Do not make more than one application per year. Do not harvest forage or hay from treated areas.
	Carbofuran		1.5 - 2.0 on 40-inch rows; or 1.8 - 2.4 oz/1,000 linear feet of row.	Apply granules at-planting in a 7-inch band and mix with covering soil. Apply liquid at-planting as a 12-inch surface band.	Use with care when applying in areas frequented by wildlife or adjacent to any body of water. Birds feeding in treated areas may be killed. Do not use in areas where adverse impact on certain Federally designated endangered/threatened species is likely. Cover or incorporate granules that are spilled during loading or on soil surfaces in field turning areas.
			1.5 on 40-inch rows; or 1.8 oz/1,000 linear feet of row.	Apply at-planting by directing granules into planter shoe with the seed or by placing the applicator tube directly behind the planter shoe so that the granules drop into the furrow and mix with the soil.	
	Ethoprop		1.5 - 3.0 on 42-inch rows; or 0.125 - 0.250/1,000 linear feet of row.	Apply one week before planting to at-planting time in 12-15-inch band on the row. Mix with the top 3-6 inches of soil immediately after application.	Do not use as a seed furrow treatment or allow granules or spray to contact seed.
	Fensulfothion		0.9 - 1.8 on 36-inch rows; or 1.0 - 2.0 oz/1,000 linear feet of row for any row spacing.	Apply at-planting in 12-inch band and thoroughly mix into the soil to a depth of 4-6 inches. Plant down center of treated band. Not recommended for control of cyst nematode.	Toxic to fish, birds, and other wildlife. Keep out of lakes, streams, or ponds. Do not apply with a knapsack or similar equipment carried on user's back.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
SOYBEAN (con.)	Phenamiphos		4.0 - 6.0	Apply overall at-planting. Distribute granules evenly and immediately incorporate to a depth of 2-6 inches. With the emulsifiable formulation, spray over entire area, using sufficient water and thorough incorporation to ensure uniform distribution. Use highest rate with high nematode populations.	The use of the emulsifiable formulation as a band or broadcast application is for California only, whereas in-furrow/covering soil applications of both the emulsifiable and granular formulations are not. Where band applications are used on narrow row crops, do not use band widths that will allow treated areas to overlap. When applied to soybeans, crop injury from propanil drift may be intensified. Use only as a band application where metribuzin is used for weed control. Any food crop not specified on label may be planted into treated areas 120 days after last application. Any cover crop planted during the 120-day period must be plowed under and not grazed. Do not apply with a knapsack or similar equipment carried on the user's back. Toxic to fish and wildlife.
			0.9 - 3.6 on 36-inch rows; or 1.0 - 4.0 oz/1,000 feet of row for any row spacing.	Apply at-planting in 6-18-inch band and incorporate 2-6 inches deep or place in furrow/covering soil behind the seed drop in front of the covering devices.	
SUNFLOWER					See general statement.

VEGETABLE CROPS

by

A. W. Johnson, Arnold Steele, Charles Heald, and Danny Gay

GENERAL VEGETABLE CROP USES

The chemicals listed in this section of the table can be considered for their use as nematicides for preplant treatments in soil in which vegetable crops are to be grown. General conditions of use of these nematicides are similar for all these crops, and the nematicides do not require tolerances. Other chemicals, listed under the various vegetable crops, can also be considered for use as nematicides, but these require more specific conditions of use or tolerances, or both. Consult local production specialists before proceeding with treatments.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
VEGETABLE CROPS	Chloropicrin		480 - 630 0.5-1.5/cu yd.	Preplant for seedbed soil. Preplant for bulk treatment of rooting soil.	Exposure period 24-48 hours. After exposure period, aerate 7-14 days before planting. Max. 1,076 lb/acre. See exception for celery in Florida.
	1,3-D		84 - 250	Preplant overall for mineral soils.	Limit 600 lb/acre. Wait 14-21 days before planting for mineral soils, 21 days or more for muck and peat soils. These periods must be extended in case of heavy rains or temperatures below 60°F. A minimum of 300 lb/acre on mineral soils for control of cyst nematodes; for this treatment, the waiting period before planting is 21 to 28 days.
			220 - 600	Preplant overall for muck and peat soils.	
			42 - 100	Preplant in row for mineral soils.	
			84 - 200	Preplant in row for muck or peat soils.	
	Metham		160 - 400	Preplant overall for fields.	For soil injection or flood irrigation, plastic cover can be used; keep in place 24-28 hours. Wait at least 21 days before planting, 30 days at low temperature or at high rates of application.
			300 - 400 (1.5-2.0 pt/100 sq ft)	Preplant overall for seedbeds.	

END OF GENERAL STATEMENT

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
ARTICHOKE				Preplant in row or overall.	See general statement.
ASPARAGUS	1,3-D		14 - 33	Preplant in row or overall.	See general statement.
BEAN, LIMA	1,3-D		14 - 33	Preplant in row or overall.	See general statement.
	Ethoprop		2.0 - 3.0	Preplant incorporate in a 12-15-inch band on the row.	Wait 0 to 3 days and seed.
BEAN, SNAP	Ethoprop		2.0 - 3.0 6.0 - 8.0		Treatment as for bean, lima.
BEANS (DRY)	Aldicarb		0.92 - 1.71	Preplant incorporate in a 6-8-inch band or cover with 1-2 in of soil.	
BEET, TABLE					See general statement.
BROCCOLI	1,3-D		14 - 33	Preplant in row or overall.	See general statement.
	MBR		150 - 235	Preplant overall for seedbeds and plant beds.	Expose to fumigation under plastic tarp for at least 24 hours (up to 48 hours). Aerate for a minimum of 3 days before seeding or 5-14 days before setting vegetative growth.
BRUSSELS SPROUTS (transplants)	Phenamiphos		4.0 - 6.0 1.5 - [illegible].0	Preplant overall. Preplant in 12-15-in band on row.	Plant after incorporating granules 2-6 inches in soil.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
CABBAGE (transplants and direct seeded).	Phenamiphos				Treatment as for brussels sprouts.
CANTALOUP	MBR				Treatment as for broccoli.
	Oxamyl	--	2 - 4	Preplant broadcast, incorporate 2-4 in into the soil.	
			0.6 - 1.34	Preplant row, 40-in, incorporate 2-4 in into the soil.	
			0.5 - 1.0	Foliar spray - apply sufficient water for uniform coverage of foliage.	First application 2-4 weeks after planting, repeat 14-21 days later. Do not treat within 7 days of harvest.
CARROT	1,3-D				Treatment as for asparagus.
	Oxamyl		4-8 in 20 gal water	Preplant broadcast, incorporate 4-6 in deep.	
			2-4 in 20 gal water	At-planting seed furrow, incorporate 4-6 in deep.	
CAULIFLOWER	1,3-D				Treatment as for asparagus.
	MBR				Treatment as for broccoli.
CELERIAC					See general statement.
CELERY	Chloropicrin		1,021	Preplant.	Seedbeds only; Florida only.
CHIVES					See general statement.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
COLLARDS					See general statement.
CORN, SWEET	(see sweet corn)				
CUCUMBER	Carbofuran		2.0	Row, 60-in, apply in a 12-15-in band and incorporate in the top 3 in of soil.	
	1,3-D				Treatment as for asparagus.
	Ethoprop		3.9	Apply on 12-15-inch band of row, immediately mix 2-3 in deep and seed.	
	Oxamyl				Treatment as for cantaloup.
EGGPLANT	1,3-D				Treatment as for asparagus.
	MBR				Treatment as for broccoli.
ENDIVE (ESCAROLE)	none				
GARLIC	(see onion and garlic)				
HONEYDEW MELON	Oxamyl				Treatment as for cantaloup.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
HORSERADISH					See general statement.
KALE					See general statement.
KOHLRABI					See general statement.
LETTUCE	1,3-D				Treatment as for asparagus.
MELONS	Carbofuran				Treatment as for cucumber.
	1,3-D				Treatment as for asparagus.
MUSKMELON (see cantaloup).	MBR				Treatment as for broccoli.
MUSTARD GREENS					See general statement.
OKRA	1,3-D				Treatment as for asparagus.
ONION AND GARLIC					See general statement.
PARSNIP					See general statement.
PEA (BLACKEYE)					See general statement.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
PEA, GARDEN AND FIELD					See general statement.
PEPPER	1,3-D				Treatment as for asparagus.
	MBR				Treatment as for broccoli.
PEPPER (BELL)	Oxamyl		0.5	Apply in 200 gal of water during transplanting.	Do not treat within 7 days of harvest.
POTATO (WHITE)	Aldicarb	90 days for planting application; 50 days for post-emergence application.	3.0 (0.32 oz active/ 100 ft of row).	Apply granules with seed pieces in planting furrow and cover with soil, or apply granules in an 8-in band and work into the soil or cover with soil to a depth of 4 in. Plant seed pieces in treated zone.	Do not make more than one application per crop. Do not allow livestock to graze in treated areas before harvest. Do not apply granular materials to soil surface unless immediately incorporated into the soil with rototiller or other device.
	1,3-D				Treatment as for asparagus.
PUMPKIN	Carbofuran				Treatment as for cucumber.
RADISH					See general statement.
RHUBARB					See general statement.
RUTABAGA					See general statement.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
SALSIFY					See general statement.
SPINACH					See general statement.
SQUASH	Carbofuran				Treatment as for cucumber.
	Oxamyl				Treatment as for cantaloup.
SWEET CORN	1,3-D				Treatment as for asparagus.
	Ethoprop		6.0 1.5 - 2.0	Preplant, incorporate overall. Preplant, incorporate 2-4 in deep in 12-15-in band on row (40-in).	Plant after incorporating granules in soil. Do not use as a seed furrow treatment.
	Fensulfothion		1.83	Apply on row, 12-in band and incorporate 3 in.	
	Terbufos		8 oz formulation per 1,000-ft row.	Place granules directly in the seed furrow behind planter shoe.	
SWEET POTATO	Ethoprop		6.0 - 8.0	Preplant, incorporate 4-8 in deep, overall.	Allow at least 14-21 days before planting. Limit is 4.0 lb active/12,400 linear feet.
	Fensulfothion		3.0 - 6.9	Preplant, incorporate 6 in deep, overall.	Plant after incorporating granules in soil. No waiting period before planting.

Crop	Nematicide	Min. days from last application to harvest or feeding	Pounds of active ingredient to apply per acre unless otherwise indicated	Where and when to apply	Safety restrictions and remarks
SWISS CHARD	Aldicarb		3.0	Apply on row 12-15-in band and incorporate 4-8 in deep, plant.	
	Oxamyl		4 - 6	Apply in 20 gal water per acre. Thoroughly incorporate into soil 4-6 in deep.	
			2 - 6	Apply in 200 gal transplant water per acre.	
TOMATO	Fensulfothion		10-20	Preplant, incorporate 6 in deep, overall.	Plant after incorporating granules or liquid in soil.
			3.2 - 6.3 (0.02-0.05 lb active/ 100 ft of row).	Preplant, incorporate 6 in deep in a 12-in band on row.	
	MBR		180 - 350	Preplant overall for seedbeds and plant beds.	Expose to fumigation under gas-proof tarpaulin for 48 hours. Aerate soil for 2 weeks before planting.
TURNIP					See general statement.
WATERMELON	Oxamyl				Treatment as for cantaloup.
ZUCCHINI					See general statement.

USE PESTICIDES SAFELY – READ THE LABEL

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